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ABSTRACT

This 3-year project examined the processes and strategies employed by English-as-a-Second-Language (ESL) and native-English-speaking students when learning from academic texts. A conceptual model guided the analysis of talk aloud protocols elicited from students as they answered questions from textbook materials used in an introductory oceanography class. Results indicated that knowledge base differences were more important than language group differences, and the most difficult questions were those requiring application of textbook information to a new situation. The data suggest that ESL students with high levels of domain-specific knowledge may compensate for less than perfect proficiency in English by employing relevant conceptual knowledge and using that knowledge to aid text processing. Overall, project activities indicate that ESL and native English speakers attempt to use similar strategies when they read text. Most individuals demonstrated flexibility in the strategies they used for comprehension. Reasons for differences in performance appeared to reside in the likelihood that the strategy produced the "correct" result and in processing efficiency. Important questions for future research are those that address the nature of the cognitive, motivational, and attitudinal costs of inefficient processing and the developmental course of efficient processing in English by ESL speakers. Twenty-eight tables and 13 figures are included. (Author/JL)

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Reasoning and Comprehension Processes of Linguistic Minority Persons Learning from Text

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This 3-year project examined the processes and strategies of ESL and native English speaking students negotiating the demands of learning from academic texts. A conceptual model guided the analysis of talk-aloud protocols that were elicited from students as they answered questions drawn from text book materials they were using in an introductory oceanography class. Results indicated that students who had a relatively good knowledge base for science concepts used in oceanography performed better and used different strategies than students who had little relevant prior knowledge. This was the case for both native English and ESL students. Knowledge base differences were more important than language group differences. The most difficult questions were those that required application of textbook information to a new situation. The data suggested that ESL students with high levels of domain-specific knowledge may compensate for less than perfect proficiency in English by activating relevant conceptual knowledge and using that to aid text processing. (Abstract continues - over)

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19. Abstract continued

Based on the protocol data, certain linguistic devices that signal the semantic organization of sentences in text were identified for further study (Years 2 & 3). Four types of connectors were examined: sequentials, adversatives, additives, and causals. The effects on recall of including explicit sequence connectors in text were similar for native English and ESL speakers: inclusion led to greater recall. The markers affected the reading behavior of the native English but not the ESL speakers. Analyses of the traces of the reading behavior revealed that most individuals used at least two or three global strategies for reading. Localized rereading strategies were related to both structural and semantic properties of the texts. A second series of studies examined knowledge of connectors as cohesion devices. A multiple choice, cloze task in conjunction with response justifications and confidence ratings indicated that native English speakers were more often correct than ESL speakers but the differential pattern of difficulty across the connectors was identical across the language groups. When causal or additive connectors were the appropriate choice, performance was better than when adversative or sequential connectors were appropriate to the cloze slot. Response justifications for correct responses indicated that all students were aware of the functions and meanings of the four types of connectors. Error analyses indicated that there was a general bias toward selecting additive and causal alternatives, especially among the least proficient ESL students. Response justifications for incorrect responses indicated that a major source of error was inaccurate comprehension of the relation indicated by the text. When incorrect relational inferences were made, students had difficulty selecting the connector alternative that matched the inferred (but incorrect) relation.

Overall, project activities indicate that ESL and native English speakers attempt to use similar strategies when they read text. Most individuals in each group demonstrated flexibility in the strategies they used for comprehension. Differences in performance appeared to reside in the likelihood that the strategy produced the "correct" result and in processing efficiency. Important questions for subsequent research are those that address (1) the nature of the cognitive, motivational and attitudinal costs of inefficient processing, and (2) the developmental course of efficient processing in English by ESL speakers.

Reasoning and Comprehension Processes of Linguistic Minority Persons Learning from Text

The general goals of the three year project "Reasoning and Comprehension of Linguistic Minority Persons learning from Text" have been to examine the processes and proficiencies called upon when nonnative speakers of English attempt to learn new information from written text. A particular focus has been on text and task characteristics that interact with learner skills, leading in some cases to highly successful performance but in others to quite marginal performance. A specific concern was to identify the nature of the problems, if any, that are unique to nonnative English speakers. The empirical activities conducted under the auspices of this project include:

- A verbal protocol investigation of the strategies students used to answer questions from texts typical of the introductory textbook material prevalent in first and second year college-level courses (Goldman & Durán, 1987; 1988)
- An analysis of the rhetorical and stylistic mechanisms authors of text use to provide cues to both global and local organization of the presented information (Durán, Goldman & Smith, 1989).
- A series of experimental studies of the effects of enumeration markers on the reading time and recall behavior of native and nonnative English speaking college students (Goldman, 1988a,b,c).
- A series of experimental studies of native and nonnative English speaking college students' understandings of the functions and appropriate usage of four types of conjunctions, a category of cohesion devices that specify the logical relationships among informational units in text (Goldman & Murray, 1989).

Several MacIntosh software applications were developed to conduct the experimental studies. Each program presents text and allows the tracking of the reading behavior of the students. One application, READIT!, presents text segments in sequential order and permits the student to go back and forth among segments (Saul, Pohl, & Goldman,

1988). Inspection time data are collected and there is an application that summarizes the data for each passage. The second application is a variant of the moving window technique (Gontier, Saul, & Goldman, 1989). An entire text is presented but the actual text is masked with black lines. Students select the sentence they want to read and only that sentence is exposed. Sequence and inspection time are recorded. These applications have permitted the analysis and comparison of reading strategies employed by native and nonnative English speakers as they perform the experimental tasks.

This final report summarizes the results of the foregoing project activities. The overarching theoretical framework and assumptions about comprehension and reasoning that have guided all of the work are reviewed first. This section is followed by a discussion of the specific investigations and the major results of each. Further information regarding each project is available in the indicated technical reports and publications.

I. THEORETICAL FRAMEWORK OF THE PROJECT

The theoretical framework that has guided this work is that reasoning and comprehension are the processes involved in acquiring new information from written text. We assume that comprehension is an interactive process; as such, the characteristics of the learner, the text, and the task impact the cognitive and metacognitive activities associated with learning (e.g., Brown, Campione, & Day, 1981). A text may be said to be understood when a coherent representation of it has been constructed by the reader (e.g., Kintsch & van Dijk, 1978). The ease with which such a representation can be constructed is affected by text factors such as vocabulary, sentence structures, and local and global organizational devices. It is also affected by how much the reader already knows about the topic of the text. Finally, the purpose for reading and the specific task that the learner is trying to accomplish influence the specific sort of representation that will be most functional.

Comprehension difficulties often arise because the level of linguistic proficiency and the degree of domain-specific knowledge assumed by text exceed that possessed by the

reader. For example, unfamiliar vocabulary may make a text difficult to understand. One purpose of informational text is to communicate the meaning of key concepts and terms in the domain. Thus, text whose function is to impart such new information is likely to have many unfamiliar vocabulary terms. In addition, comprehension difficulty may be associated with understanding how the words in a sentence and/or the sentences in the entire passage relate to one another. The strategies readers use for resolving comprehension difficulties often vary but can include ignoring words that are not understood, rereading, and consulting an outside expert (Collins & Smith, 1981).

Empirical investigations of comprehension as an interactive process involving the learner, the task and the text are scarce (see for examples of such work Ammon, 1987; Langer, 1985). In our project activities we have been concerned with two learner characteristics: (1) the language proficiency of nonnative English speakers, and (2) domain-specific prior knowledge. We have focused on language proficiency particularly as it relates to the language used in academic texts. Prior knowledge is of interest particularly as it interacts with language proficiency. High versus low knowledge effects on comprehension and reasoning have been demonstrated by a number of researchers (e.g., Chiesi, Spillich, & Voss, 1979; Dee Lucas & Larkin, 1986; Spilich, Vesonder, Chiesi, & Voss, 1979). However, little is known about the relationship between general language proficiencies and domain-specific knowledge as they affect the learner's task of acquiring new information from text.

In our work we have focused on text characteristics that involve language structures that express relationships among individual units of information. Such devices impact text cohesion and the learner's ability to construct a coherent representation of the text. Some of the relevant language structures are most evident at the sentence level. These include, e.g., conjunctions, conditionals, performatives, and quantification terms and phrases (see for further discussion Celce-Murcia & Larson-Freeman, 1983; Halliday &

Hasan, 1976). Other relevant language structures operate at the level of an entire text and provide an organizing relationship for all of the ideas in the text. Examples of such global structures are compare/contrast, thesis/evidence, and cause-effect . These global structures are typically signalled by rhetorical devices at the paragraph level and awareness of them allows the learner to more easily encode and construct a coherent mental representation of the incoming information (e. g. Brewer, 1980; Meyer, Brandt, & Bluth, 1980).

The task characteristics that we have been looking at arise from a consideration of comprehension skills hierarchies (Bormuth, Manning, Carr & Pearson, 1970; Rosenshine, 1980) and envisionment levels (Fillmore, 1983; Kay, 1987; Langer, 1986). Comprehension tasks can be thought of as varying along a continuum reflecting the degree to which the task can be successfully completed with "only" the text as compared to requiring material and knowledge external to the text (see for discussion Goldman, 1985). Comprehension skills hierarchies reflect this continuum in that these ordered skills imply an increasingly more sophisticated understanding as one moves from "literal" comprehension of the text, to making simple inferences from the text, to engaging in more complex inferential reasoning based on the information in the text. Variations in dependency on the text are also reflected in the envisionment levels of reasoning proposed by Fillmore (1983). Envisionment levels refer to variations in individuals' understanding of the world described in a text. These levels range from the most basic, i.e., "Understanding independent statements in a text", to the most complex, i.e., "Embellishing the text world in light of existing knowledge and in terms of possible extensions and underlying generalities". The more basic envisionment levels are more dependent on the text, reflect more literal understanding of the material and assessment typically involves different kinds of comprehension tasks than does assessment of more complex understandings.

Project activities have examined a range of envisionment levels using question answering (Goldman & Durán, 1988), cued recall (Goldman, 1988a,b), and cloze completion tasks (Goldman & Murray, 1989). Furthermore we have collected several dependent measures that permitted inferences regarding metacognitive and strategic aspects of performance (Goldman, 1988c). These measures included confidence ratings, reading time, verbal justifications, and a method for tracking the sequence in which the sentences in a text are examined.

II. Answering Questions from Oceanography Texts

We began our investigations of the interaction of learner, task and text characteristics with a descriptive study of behavior of students engaged in answering questions based on material they had read in their textbooks, a task typical of introductory-level college courses. Participants were native-English and ESL speakers who varied in their levels of expertise in oceanography and oceanography-related domains. Task variables were manipulated by including questions for which the answers required students to engage in different "levels" of comprehension. In fact, interactions between text and task characteristics created situations where questions that looked "literal" actually required going beyond the information in the text. For example, if the text stated the answer to a yes-no question, the question is categorized as a literal question. On the other hand, the answer to this same question might not be explicitly stated in the text, in which case the learner would have to engage in inferential reasoning to answer it. In the latter case, correctly answering would indicate more complex levels of comprehension than in the former case. Furthermore, different question-answering strategies would be expected in the two cases.

Thus, depending on the nature of the text, the task, and the relationship between the text and the task, different strategies for accomplishing the task may be called for. Some questions and tasks may be answered in an almost "rote" fashion by, literally, matching the words in the question to the same words in the text. Other questions and tasks may require

using the information in the text to draw conclusions and/or relate the material to the learner's own world (Goldman, 1985; Langer, 1985; Rosenshine, 1980). In general, the difficulty associated with achieving correct performance was expected to increase as "distance" from the text increased.

Our purpose in the research was to examine the strategies learners employed, given their levels of expertise in the domain, their English language proficiency and the relationship between the particular question and the text. For this purpose, we employed a think-aloud protocol methodology. Despite the potential difficulty of talking and working with English text concurrently, we note that think-aloud procedures have been efficaciously used with ESL students in previous work on reading and reading strategies (e.g. Benedetto, 1986; Block, 1986 a,b). Within task variation was introduced by including questions that varied along the text-dependency continuum and hence had the potential for eliciting different strategies from the students.

Method

Materials

Two sections of text were selected from the book the subjects were using in their introductory oceanography course, Ocean Science (Stowe, 1983). The text sections were comparable in terms of length (approximately 1500 words in each selection) and featured a representative sampling of the types of concepts students in the course have to deal with, including definitions of terms, properties of geophysical phenomena, mathematical relations and physical laws. (For further details of the materials, refer to Goldman & Duran, 1987, 1988.)

Comprehension questions were largely drawn from the study guide developed by the instructor of the course, but in three cases were developed by the authors. Correct answers to each question were provided by the course instructor. Specific relations between the questions and the texts were determined by identifying and comparing the explicit predicate

propositions and coherence relations occurring in each. Based on this analysis we determined that questions varied in terms of how closely they matched the surface structure of the text; in their reliance on technical knowledge (especially vocabulary), presumably acquired prior to taking the oceanography course; and in their dependence on reasoning processes for correct solution. This variation in types of questions permitted the examination of different solution methods, and their relation to the various question types.

Question types

Five question types were identified based on an analysis of (1) the relationship between the question and text, (2) the demands made on the knowledge base, and (3) previous empirical work on differences between various types of questions (e.g., Bormuth, et al., 1970; Goldman, 1985; Langer, 1986; Rosenshine, 1980). Table 1 summarizes the five types and indicates how the 18 separate questions employed in the study were distributed across types. In the first type of question a verbatim relationship exists between the question and the text: The answer is given explicitly and there is a direct match between the question wording and the text wording. To answer this kind of question, the learner merely has to locate the appropriate section in the text and find the matching language.

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Insert Table 1 about here

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The second type of question involves a paraphrase relationship between the question and the text: The text explicitly gives the answer if certain vocabulary equivalences and conversions are made by the learner. These conversions frequently depend on prior knowledge and apparently assume that the learner already knows certain technical vocabulary (e.g. factor, ratio) because such terms are not defined anywhere in the text. This vocabulary issue may be extremely cogent for predicting nonnative English speakers' success on these types of questions. For this type of question, once the appropriate

vocabulary conversions are done and conceptual equivalences established, the relevant text portion typically is circumscribed and localized in one small area of the text. Thus, question types 1 and 2 tend to involve locating specific sentences in the text and reflect largely literal comprehension and local envisionment.

The third type of question, verbatim look-up plus comparison, involves reasoning with information found in the text. The text gives the necessary information explicitly and there is usually a direct match between the question wording and the text. Thus, locating the information proceeds much like in type 1 questions. However, once the information is "found", it must then be compared to other information. The fourth type of question requires integration of information across several paragraphs of the text. There may be either a verbatim or paraphrase relationship between the question and the text but the text provides the relevant information in a number of paragraphs. The information must be coordinated and analyzed to construct the correct answer. These types of questions would lend themselves to partially correct answers if learners were to locate only one relevant section of text. This type of question thus requires integrating local knowledge.

The last type of question requires reasoning, application and/or computation. Questions of this type involve using a text-provided formula, rule or relationship to get the precisely correct answer. Locating the formula, rule or relationship involves a verbatim or paraphrase match or look-up process but answers to questions of this type cannot be found in the book directly. Rather, the learner must disembed the relevant information and apply it to a new situation described in the question. This type of question thus requires envisionment or comprehension levels that involve extending the text beyond its own confines whereas the other four types of questions stay within the boundaries of the text. (The texts, questions and answers are available in Goldman & Durán, 1987)

Subjects.

Seven students volunteered to participate in the question-answering protocol study. Six of the students were enrolled in the introductory oceanography course on campus and the seventh (HS) was the teaching assistant for the course and our "a priori" expert in the content domain. Students completed a background questionnaire dealing with academic information, language skills and study habits. Table 2 provides a summary of the most pertinent information from this questionnaire. The teaching assistant and three of the students were native English speakers (MR, LH, and DW). The other three students (GL, II, and EH) were from three different nonEnglish language backgrounds but were relatively proficient in English. GL rated his English language skills "extremely good"; II and EH each rated their skills "good". The four native English speakers rated their own English language skills "extremely good." The language of instruction during high school had been English for all the students. EH had had the least exposure to English, having entered the United States six years ago, at which time she had her first contacts with English. II and GL were first exposed to English at the age of 4 years. Of the nonnative English speakers, only EH reported using her native language daily. GL and II reported that they used their native languages to read newspaper or magazine material, but rarely.

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Insert Table 2 about here

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All students' high-school backgrounds included courses in chemistry and/or biology. MR and DW were college seniors, GL a junior, LH a sophomore and EH and II were freshmen at the time of the study and thus experience with college-level science courses varied. MR had an extensive background in physics and HS in oceanography. GL had taken astronomy. The other three students had no college-level science courses but II had had physics in high school. Based on this background information, it appeared that DW, LH, EH

and perhaps II would have less prior knowledge relevant to questions on oceanography than the other three. Table 2 also describes the self-ratings of English language skills related to academic performance. These ratings suggest that the native and nonnative English speakers differed primarily in terms of their command of science vocabulary with the latter indicating only moderate command of such terms. Ratings on learning from English lectures were "good" and "extremely good" for all students. Learning from English text skills were rated higher ("extremely good") by the native English speakers as compared to the nonnative English speakers ("good").

Procedure.

Volunteers were recruited from students in the introductory oceanography class. They were paid $5 per hour for their participation. Students were told that we were interested in how they went about answering questions on oceanography material and that we wanted them to think-aloud as they worked on several questions that we would give them. Then the think-aloud method was described and modeled, following procedures outlined by Ericsson and Simon (1984).

Following practice with the verbal protocol procedure, the first text selection was presented and subjects were free to read over it. Then the questions were presented one at a time for the students to answer. Interviewer probes were used to (1) encourage subjects to report what they were looking at and thinking about as they answered each question, and (2) clarify and disambiguate some of the subjects' comments. Approximately 3-4 weeks later, students returned and they worked with the second text selection. After it was read over, the questions were presented one at a time and subjects were asked to answer them. Sessions were audiotaped and later transcribed.

Analysis of the Question-Answering Protocols

Conceptual Process model

We developed a general conceptual model of the processes and sources of information that might be involved in answering questions based on academic text materials. This conceptual model, shown in Table 3, indicates four major processing events and the goals associated with each one. In addition, metacognitive processing events are shown as optional. Monitoring can apply to any of the processing events and/or to learners' general thoughts about their performance, the task, the text, etc. In discussing the model, examples from the protocols are used illustratively. However, the conceptual model was not derived from the protocols; rather its development was influenced by prior empirical research illustrating that comprehension and question answering may be profitably conceptualized as constructive, problem solving activities (e.g., Ammon, 1987; Bransford & Johnson, 1973; Collins, Brown & Larkin, 1980; Goldman, 1985; McLaughlin, 1987). We were particularly interested in the relation between the question and the text and how that relation impacted, if at all, on students' solution strategies.

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Insert Table 3 about here

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Each major processing event shown in Table 3 may be further "unpacked," or expanded, into its constituent processes, goals and procedures. An extended discussion of the conceptual model appears in Goldman and Durán (1988) and only a summary presentation is presented here. The first processing event, question encoding, will be used to illustrate the nature of the model. Question encoding has two primary goals. The first goal is to determine the type of answer required by the question. Essentially, the learner needs to have some sense of (1) what form the answer will take, i.e., one word, a sentence, several sentences; (2) the structural requirements on the answer, i.e., two concepts must be compared versus

discussing a single concept; (3) whether verbal or numeric information is sought; and (4) the likelihood that the answer was already given in the text or is present in memory, i.e., does the question wording indicate that a novel application or situation is being addressed? Without even considering the relation between the question and the text, differences in these four areas imply that different strategies are likely to be useful and that arriving at the answers involves differential degrees of cognitive effort.

Furthermore, as we discussed in the presentation of question types, questions vary in terms of (1) the level of envisionment demanded (Langer, 1985), (2) the relationship between the text and the question (Pearson & Johnson, 1978; Rosenshine, 1980) and, (3) the type and extent of reasoning necessary to arrive at the answer (Goldman, 1985). Variations in the reasoning requirements of questions are not coterminus with the explicit-implicit factor, nor with the envisionment level. They depend on the form of the target answer: Some questions involve simply reporting a specific "fact" or datum; others require explanation, comparison and sometimes application to a new situation.

Two sample questions illustrate the nature of the differences among the questions and kinds of answers demanded. In the example question below there are several parts, each of which requires a numeric response, but which differ in terms of how that numeric response may be determined:

a) Suppose air at 25° C is saturated (100% relative humidity). What fraction of the air is water? (b) What would be the answer if the temperature were 35°? (c) 15°? (d) 5°? (e) Does the answer change by roughly a factor of 2 for every 10°?

The answers to parts *a* and *e* can be found verbatim in the text; the answers to *c* and *d* can be read directly from a table given in the text. The answer to *b* must be computed but it can be computed in two ways. The individual can either apply the rule referred to in part *e* of the question or can interpolate from the series given in the table in the text. A second example question illustrates an explanation question where vocabulary is a critical issue:

"Briefly explain how 'echoes' can be used to measure the depths of discontinuities in the earth's internal structure." To locate relevant portions of the text or to access the appropriate concept in memory, the learner must understand the equivalence between the phrase in the question, *depths of discontinuities* , and the phrase used in the text *interfaces between materials.* Furthermore, there are several sections of the text that are relevant and two factors that need to be discussed: time and speed. Time is discussed in a three sentence section that is separated by nine sentences from the section that deals explicitly with the time and speed relationship. To give the complete answer, the learner must integrate across sections of text and extract the pertinent relationship.

"The first item (time) could be read from your seismograph, but there is no direct way to know the speed of seismic waves deep within the earth. Fortunately, this information may be inferred from data, due to the other important property of waves.
This second property is...." (speed is mentioned again 3 sentences later.)

The text does indicate that the learner ought to read on for the complete answer but sensitivity to this rhetorical signal may be related to English language proficiency.

To accomplish the goal of determining what type of reasoning and what type of answer the question requires, the primary means is to rely on the language of the question. Analysis of the language draws on prior experiences with other academic texts and a sensitivity to the semantics of various question words, such as <u>how many</u>, <u>what</u> and <u>why</u>. To the knowledgeable individual, these questions words provide cues to the appropriate form of the answer. For example, a "how many" question ought to indicate the need for a specific quantity, a "why" for a causal or logical explanation of the phenomenon mentioned in the question. In addition, learners may use the task context and constraints to further define the nature of the answer. In an untimed situation, one can afford to be more discursive than in a time-limited one. Furthermore, the space provided for the answer often gives the learner information regarding the extent of the answer, e.g., a blank in the middle of a sentence versus a question followed by a half page of blank space.

The second major goal of question encoding is to determine starting points for a search space. A primary means of doing this is to use technical terms and keywords mentioned in the question as entry points to memory and/or the textbook. When the question uses words that match those used in the headings and subheadings of the text, learners are virtually assured of a reasonably well-defined search space in the text. Keyword matching is also facilitated by the use of boldface or italics in the body of the text. In defining a search space in memory, the keywords in the question behave similarly but the success of a match will vary depending on learners' individual mental representations of the text information. Regardless of whether the learner is defining a search space in the text or in semantic memory, there is the possibility that the words in the question will be seductively appealing as cues, when in fact the question really requires original thinking or the application of presented material. Questions of this sort are not only at more complex envisionment levels but also may provide "false" signals to the learner, by creating the impression that the answer is "in the book". Thus, question encoding has important outcomes for the Search component of the question-answering model (see Table 3) in that question analysis helps define the search space as well as the type of answer for which the learner is searching.

The Search processing events are "unpacked" in a manner similar to question encoding. Search may proceed either in memory or in an external source such as a textbook, notes or supplementary reference material and the goals differ somewhat for memory compared to external searches. The goals for memory search distinguish between two outcomes. In the first goal, the answer is found in memory and no external search is undertaken. If memory search is abandoned for external-source search, a second goal of the memory search is to determine alternate sources for the answer. Thus, a memory search may not produce the answer but may further define, and refine, subsequent search spaces. External source search can thus be facilitated by a memory search that does not yield the specific answer to the question. The memory search phase of the model is the one about

which we have the least to say based on the protocol data (see Reder, 1987, for a recent theoretical and empirical focus on question answering from memory).

Goals for external searches are similar to those for memory in that we assume the operation of decision, monitoring and evaluation processes during the course of the search. In searching a textbook, learners may have three major goals that are interdependent and interrelated. One goal is to delimit the search space by using the results of question encoding and memory search to constrain and guide textbook processing. This goal becomes increasingly important as the amount of potentially appropriate text material increases. A second goal, finding information relevant to the question, will be achieved with less effort if the search space can be appropriately limited but will be more difficult if the search space is incorrectly constrained.

Given a section of text to search, search may be global or guided. Global searches begin with the learner having only a vaguely defined search space, e. g., "I'll look in the text for that. It must be there somewhere." Such searches are typically characterized by scanning or skimming and may be exhaustive or self-terminating. Monitoring, evaluation and decision processes are tuned to the occurrence of concepts, vocabulary, or other text material that "matches" the requirements of the question. When a match is encountered, the learner's attention becomes focused on that section of text and more careful examination of the text replaces the skimming behavior. The search process, in effect, changes to a guided search. Guided search is, from the outset, targeted at a defined search space, a localized area of the text. Keywords and topics mentioned in the question are used by the learner to explicitly identify and focus on specific sections of text, e. g., "This question is about gravity. That's section two. I'll look there."

The third goal becomes active once question-relevant information is located: the information must be meaningfully processed in the context of the task defined by the question. The learner must extract the relevant information in a form that suits the task

demands. For some questions, just recognizing the right material and reading it from the text is sufficient. For other types of questions, summarization may be called for and in still others, the learner may need to engage in extended reasoning and knowledge application processes.

A transcribed natural language protocol for one of the subjects, DW, is shown in Table 4 and illustrates the interdependence and interrelatedness of the goals and processing events in the question encoding, memory search and text search components of the model. This particular question required the explanation of an everyday occurrence: "Explain why you feel cold when you get out of the shower". Although the text explicitly stated the answer in one self-contained paragraph, text section B.2S15-18, references to the scientific concept involved, evaporation, occur in the three paragraphs preceding, and in the four paragraphs following, the paragraph containing the answer. DW first encoded the question by reading it, defined the topic as one of the major ones in that section of text, "latent heat," and then reread the question (lines 1-3). She then gave an answer from memory, "because of the evaporation process", but evaluated her answer as insufficient for the question (line 5). She proceeded to do a text search (line 6), presumably to gather more information on evaporation and why the process works that way. She began reading in the appropriate section, B.2 Latent heat, but two paragraphs below the one containing the answer (lines 7-11). She skipped up the page to the topic sentence of the paragraph containing the answer (B.2S15). She then stated an answer that paraphrased S15 in nontechnical terms but was only partially correct because her answer deleted the details of molecular movement and its relationship to evaporation and temperature (lines 13-15), details necessary to the explanation. She evaluated this answer as missing something (line 16) and adopted a global search strategy of skimming from the beginning of Chapter 12 (lines 17-21) until she got to the first sentence of section B.1, which uses the keyword "evaporate" (line 22) She read the next two sentences (lines 23-25) and then skimmed the remainder of section B.1,

assumedly because the "evaporation" match didn't lead anywhere on the shower explanation (lines 26-37). She then read the first six sentences under section B.2 (lines 38-44), and recognized this as the relevant material (line 45). She re-read part of it (S3 - S6 in lines 46-50) and then continued reading about perspiration and evaporation (lines 51, 52). DW then proceeded to paraphrase the information she had just read (lines 53-61). However, she got tangled up, reread S8 and then reverted to her original answer. "Well, I guess I'd say evaporation, and leave it at that."

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Insert Table 4 about here

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DW started by defining the search space as information on latent heat; she then retrieved an answer from memory, evaporation. This answer guided her attempts to search the text for more information. However, DW apparently failed to see the importance of continuing with the paragraph starting with S15 (line 12); instead she engaged in a global text search that took her away from the relevant information. She never got back to this paragraph but attempted to conclude her answer to this question with a paraphrase of a less-relevant text section (B.2S7 & 8). However this section is the first section under her self-defined topic, "latent heat," that mentioned "evaporation." She monitored her understanding and the paraphrase as not terribly direct but instead of resuming a search process, she retreated back to the same answer she had originally retrieved from memory and the one that provided the impetus for the text search in the first place. We can only speculate on why she "gave up" at this point.

DW's protocol illustrates the fourth component of the question answering model, Construct and output an answer (see Table 3). Two interrelated goals involved in this process are (1) answer the question completely and (2) match the type of answer to the type of question. DW was answering a question that required an explanation and she indicated by her self-question "But what is it that causes that?" that her initial answer

("evaporation") did not really qualify as an explanation. Another learner, GL, indicated his attempt to meet the goal of answering completely, after having given a correct, partial answer to one of the questions. He stated: "Ok. I'll read it again and to find out exactly what these are used for. I mean I know they're used to measure depth but I know they have other (uses)." An optional goal in the answer component is to demonstrate that the information has been incorporated into the knowledge base. Several of the students repeatedly paraphrased text sections they had just read aloud. We interpreted this behavior as their efforts to comply with this optional goal.

A final processing event in the question-answering model is optional but encompasses processes related to the role of metacognitive behavior in the question answering process. At any time, and for any of the processing events, confirmation, monitoring and evaluation may be invoked by the learner. The outcomes of such monitoring, in part, determine the sequencing and interplay between the various processing events. For example, after reading a lengthy section of the text, a number of students were observed to reread the question. There are several related explanations for why that particular sequence occurred: first, the learner might have monitored memory for the specifics of the question and determined that the trace was not sufficiently active; second, the juxtaposition of the text and the question might help in the determination of the appropriateness of the just-read text to the exact question. Reder (1987) has suggested a third possibility: rereading may increase the familiarity of the concepts and thus the likelihood of success for direct retrieval of the answer.

Solution strategies.

Based on the conceptual model of question answering we derived a typology of solution strategies by considering which processing events, goals within processing events, and monitoring processes were involved in solution. A specific solution strategy consists of question encoding, some type of search, some set of additional processing activities

(including the empty set) and output of the answer. Four types of search were specified, each of which could be accompanied by any of four "additional" processing activities: question analysis, reasoning/inference, process monitoring or product monitoring.

The four search types were Memory Search (A), Text Search (B), Both memory and text search (C), and Text Search, Reason Beyond (D). Each search type could be augmented by the occurrence of one or more of four additional processing activities: *Question analysis* refers to rereading or analyzing the nature of the question. *Reasoning* and *inference* refer to efforts to logically manipulate given or remembered information. *Process* and *product monitoring* refer to metacognitive behavior directed at the progress of any cognitive activity (process monitoring) or at the results of search and retrieval processes (product monitoring).

Protocol Scoring.

Each subject's transcribed protocol for each question was analyzed to determine which of the solution strategies was reflected in the empirical data. To do this, we coded the natural language descriptions of the protocols for cognitive actions (e.g., recall, read, compare, monitor, evaluate) and the types of information on which the action operated (e.g., text material, question, own knowledge). Table 5 shows the coded version of the natural language protocol that was given in Table 4.

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Insert Table 5 about here

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Based on the coded protocol, a solution strategy for each question answered by each subject was determined. We adopted the convention of a 5-place code for designating solution strategies. The first place indicated the type of search (A - D) and the remaining four indicated the presence (1) or absence (0) of each of the processing activities described above. Furthermore, a superscript gives the evaluation of the final answer produced by the learner, with 1 indicating correct, 2 indicating qualitatively correct (but not

quantitatively) for those questions where a specific numerical value was requested, 3 indicating a partially correct answer, 4 an incorrect answer, and 5 no answer given. Applying this procedure to DW's coded protocol (Table 5) leads to the designation C.1011^{3}. The search type is "C" because DW recalled an answer from memory and also consulted the textbook prior to producing her final answer. Additional processing activities were rereading the question (question analysis) process monitoring ("I know that there's something in the book that I'm missing") and product monitoring ("Why does the process work that way?"). She is credited with a partially correct answer because she never explained <u>how</u> her answer, evaporation, led to feeling cold, although she made two explanatory attempts. Note that the 5-place code for the solution strategies does not distinguish between single and multiple occurrences of processing events, i.e., if one section of text was read it was counted the same as if several sections were read.

The results of applying our scoring/coding scheme to each subject's solution for each question was a distribution of solution strategies across learners and types of questions. These data were the basis of the subsequent analyses.

Results and Discussion

Several important trends were reflected in the solution strategy data. Consistent with an interactive, constructive comprehension model, task characteristics and learner characteristics affected the nature of the solution strategies. Task characteristics were reflected in the type of question: the various types were differentially difficult and there was evidence of the use of different solution strategies depending on the type of question. Learner characteristics were reflected in level of expertise within the domain and in language proficiency. While individuals tended to be relatively consistent in their strategic approach to the task, individual differences were observed and were related to both domain expertise and language background. The trends associated with task and with learner are discussed below.

Question type and task difficulty

There was a predicted order of difficulty for the five types of questions, with Type 1 expected to be the easiest and Type 5 the most difficult. Types 2, 3, and 4 were predicted to be roughly equivalent in difficulty. We also expected, based on the notion that the need for various processing activities depends on the relation between the question and the text, that solution strategies would reflect variations in task demands created by question factors (see also Reder, 1987, Experiment 6). Specifically, reasoning/inference and question analysis were predicted to occur less often for Type 1 questions as compared to the other types. Finally, we predicted that monitoring processes would occur more often for questions requiring the coordination of information from multiple paragraphs, e.g., Types 3, 4, and 5.

Question type difficulty was measured by the percent correct (quantitative or qualitative) answers and is shown in the first row of Table 6. As predicted, Type 1 questions were the easiest: 89% of the answers were correct. Type 4 questions were also relatively easy, 71% correct. The unexpected ease with which these were solved is probably due to the verbatim relation that held between this sample of Type 4 questions and the text. In this particular task context the difference between Types 1 and 4 was the amount of text that matched the question, with Type 4 questions matching over longer segments, thus requiring integration over several sections of the text.

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Insert Table 6 about here

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Those question types requiring reasoning were successfully solved 62% (Type 3) and 57% (Type 5) of the time, whereas Type 2 questions were the most difficult, showing only 39% successful solutions. We had expected that this type of question might be more difficult for ESL than for native English speakers because of the vocabulary conversions required. Both groups had equivalent correct rates (42% for the ESL and 38% for the native English speakers). However, the two groups differed in that the native English

speakers were more likely to have partially correct answers (31%) than the ESL speakers, none of whom got partial credit on answers to questions of this type. Thus, the most difficult question type, Type 2, was the type requiring knowledge of vocabulary and conceptual equivalence, primarily for technical, natural science and oceanography terms.

Question type and solution strategies

Consistent with our expectations, learners engaged in different solution strategies depending on the type of question they were attempting to answer. As shown in Table 6, for the Type 1 questions, which have a verbatim relation to the text, 90% of the correct solutions involved a simple "search plus retrieve answer" strategy. Of these, 58% were text searches and 32% were memory searches. Furthermore, about half of these single source searches involved no other processing activities. Correct solutions to Type 4 questions, which also had verbatim relations to the text, were simple "search plus retrieve answer" strategies 85% of the time, but about half of these were text and half memory searches. Not surprisingly reasoning and inference processes rarely occurred for either Type 1 or 4 questions. Solutions to the two types of verbatim questions differed principally in terms of the more frequent use of monitoring in the Type 4 questions.

Type 3 questions, verbatim "look up" plus comparison, were similar to Types 1 and 4 in terms of the search strategies used in correct solutions (85% search single source). Type 3 differed from Types 1 and 4 in that 54% of the correct solutions employed reasoning and inference processes, a difference consistent with the nature of these questions. Type 3 differed from Type 4 but was similar to Type 1 in that less than half of the correct solutions (46%) featured monitoring, principally checking the product or answer before stopping. Thus, for these three types of questions that all in some measure involve verbatim relations between text and question, there is a comparable degree of reliance on text and memory search leading to correct answer retrieval.

Correct solutions to Type 5 questions, requiring use of a formula or rule given in the text, are distinguished from Types 1, 4 and 3 in terms of the appearance of the disconfirming search strategy, i.e., the search leads to the realization that the answer is not "given" explicitly in the text but must be computed (search Type D). In conjunction with this search type, process and product monitoring are very frequent in the correct solutions and are more frequent than in the three preceding types of questions. Similar to Type 3, reasoning and inference occurred in 63% of the correct solutions. Solutions to Type 5 questions usually featured additional processes, a marked difference from Types 1 and 4.

Correct solutions to Type 2 questions were a cross between Types 1 and 4 solution strategies. Like Type 1, 83% of the correct solutions involved searching one source and answering; like Type 4, there was a high degree of monitoring (75% of the solutions). Note however, that these data represent only 39% of the attempted solutions. In other words, for those questions correctly answered, the successful vocabulary conversion allowed learners to treat these questions like verbatim questions. Given the high failure rate on Type 2 questions (61%), consideration of the solution strategies for both correct and incorrect final answers is informative. Over all solutions, the most frequent search strategy was a text search (17 of 28 solutions); however, 59% (10) of these failed to lead to correct solution. Another five memory search solutions (63% of 8 memory searches attempted) failed to lead to a correct solution. Two of three solutions using both sources failed. The inability to map the language of the question onto the language of the text appears to have been the critical obstacle to successful solution. The fact that the native English speakers were more likely than the ESL to be at least partially correct on this question type supports the conclusion that difficulties on this type of question may be related to English language proficiency.

Our findings indicate that questions requiring more literal and explicitly presented text information are easier to answer than those requiring more global levels of

envisionment. We confirmed Langer's (1986) finding that monitoring (Langer's equivalent is "puzzling") was more frequent for the questions with higher error rates. In the present study, these were the questions involving application of the information or vocabulary conversions. These types of questions draw most heavily on English langage proficiency and domain-related prior knowledge. We next consider the relation between subject-matter expertise and the solution strategies of individual learners.

Learner characteristics and solution strategy patterns

The learners in this study differed in terms of expertise in the specific subject-matter domain, oceanography, and in terms of oceanography-related course work. The "experts" were HS, who was the teaching assistant for the oceanography course, and MR, who had an extensive hard-science (physics) background. One of the nonnative English speakers, GL, had taken a related science course (astronomy) and we dubbed him "high" knowledge. A second nonnative English speaker, II, had taken physics in high school whereas the remaining nonnative English (EH) speaker and the two native English speakers (DW and LH) had had no science courses relevant to oceanography. The characteristics of the solution strategies for each of these individuals are discussed in order of "expertise" and compared in terms of the quantifiable characteristics, including percent correct, given in Table 7.

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Insert Table 7 about here

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The observed differences among the protocols can be summarized in the following way: The "expert" native English learners tended to rely on memory searches; the more successful learner engaged in optional answer confirmation. Of the lower knowledge native English speakers, one tended to rely on memory (LH) and had a high rate of incorrect answers. When she did search the text she found the correct answers only for Type 1 (verbatim) questions. Finally, DW relied on the text to a greater degree than the other native English speakers. Her solution strategies were extensive and quite often involved

question analysis, monitoring and reasoning. In general, the nonnative English speakers relied on the text to a greater degree than the native English speakers. The highest knowledge and most successful nonnative English speaker, GL, relied almost exclusively on the text and engaged in frequent question analysis and monitoring activities. EH was less successful in her efforts to use the text and was hampered frequently by vocabulary/conceptual gaps. Finally, II used memory and text searches but was frequently hampered by faulty or inadequate question encoding or text interpretation.

The foregoing characterizations were based on the simple presence or absence of the various processing activities. A complementary analysis considered the frequency of various processing activities. The frequency data index the length of solution. Two measures were computed from the coded protocols: number of actions (read, reread, skim, etc.) summed over all 18 questions answered by each learner, and number of metacognitive actions (monitor, evaluate, etc.) also summed over all 18 questions answered by each learner. These data were used in conjunction with the data in Table 7 to develop summary profiles of the seven learners. These summaries are presented in Table 8. Accuracy was used to divide the students into successful (MR and GL), moderately successful (HS and DW), and less successful learners (II, EH, and LH). The profiles capture the relationship between this classification and level of expertise, length of solution (based on the total number of cognitive actions) and degree of monitoring (based on the total number of monitoring actions).

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Insert Table 8 about here

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The profiles help to illustrate the complex interactions of text and learner that were observed. The two most successful learners (MR and GL) differed in the length of solution, with GL engaging in twice as many metacognitive and cognitive processing activities as MR. Whereas GL was high knowledge, he did not have MR's level of expertise

and may therefore have relied more on the presented information than did MR. The two moderately successful learners, HS, the content expert, and DW, a novice geology student, replicated the differences between GL and MR. Thus, lacking expertise in the domain, learners who did well tended to extensively process the written material in the context of the question and to keep careful track of their performance.

In contrast, the three less-successful learners had in common a tendency to answer quickly, i.e. to engage in relatively short solutions. Comparison of EH and II revealed identical solution success rates but showed that metacognitve processing was twice as likely for the lower knowledge learner. Finally, accuracy was lowest for the low knowledge, native English speaker, LH; she engaged in short solutions and virtually no metacognitive behavior.

The characterizations portrayed in these summary profiles suggest that successful learners may be sensitive to the need for strategies that compensate for low knowledge in a domain. Among the present learners, the primary means of compensation was relatively lengthy text processing accompanied by monitoring and evaluation of the processes and products of solution. Nonnative English speakers who are sensitive to this compensatory mechanism, and attempt to use it, may be heavily dependent on text negotiating strategies and on the necessary English language skills. In contrast, nonnative English speakers with high or expert levels of knowledge in an area would be less dependent on the language of the text; in fact such expertise might assist students less proficient in English in learning English processing skills in their content courses.

Summary and Implications

There were several important results of the analyses of strategies for question answering. First, we found a great deal of similarity among the solution strategies of the native and nonnative English speakers, consistent with previous examinations of comprehension strategies of native and second language readers (Block, 1986a,b). However, one important difference was a tendency for the nonnative English speakers to rely

more on the text than the native English speakers. Second, the more successful learners, i.e., those who tended to get the correct answers, engaged in cognitive monitoring, especially of their answers or candidate answers. Unsuccessful solutions were associated with largely unmonitored memory searches and this was a particular obstacle for one of the "novice" native speakers. Finally, the task requirements, captured in the analysis of the relation between question type and solution strategy, affected the characteristics of the solution strategies. The simplest strategies occurred for the verbatim questions, which had the highest rate of successful solution. The hardest question type was the one requiring vocabulary conversion and/or paraphrases to match the text and the question.

The protocol analyses also revealed that text searches and comprehension monitoring were guided, in part, by rhetorical devices that signal various organizational and semantic information to the reader (e.g., Lorch, in press; Durán, Goldman, & Smith, 1989). In particular, there was one section of the Oceanography text that used the sequential markers *first* and *second.* Both native English and ESL speakers were observed to use the term *Second* to ask themselves if they knew what was first. Other types of rhetorical devices mark the semantic relations among the different elements of information, e.g., *however, in addition, as a result.* Understanding the semantic relations signalled by such rhetorical devices aids the process of constructing a coherent, internal representation of the text.

We undertook a series of experimental studies that systematically pursued issues of comprehension and use of rhetorical devices to guide text processing and information acquisition. Specifically, the work had two foci, each of which was concerned with potential differences between native and nonnative English speakers. The first focus was on the effects of a specific rhetorical device, sequence markers, on reading behavior and memory for the information read (Goldman, 1988a, b, c). The second focus was on students' understanding of the usage conditions for four types of connectors: additives, causals,

adversatives, and sequentials. We wished to determine if the four types of connectors were differentially difficult for readers to understand and whether there were strategic differences in how students performed on a rational cloze task where the deleted words were connectors (Goldman & Murray, 1989).

III. Studies of the Effects of Sequence Markers on the Reading and Recall Behavior of Native English and ESL Students

Four experiments examined the effects of sequence markers on the reading and retention performance of ESL and native English speaking college students. However, prior to conducting these studies, we determined that the sequence marker manipulations did create passages that were differentially easy to understand (Refer to Experiment 1 in Goldman, 1988). Three studies described here (Experiments 2, 3, and 4 in Goldman, 1989) pursued the reading and information retention issues. Experiment 2 examined recall of target information by monolingual, native English speaking students. Experiment 3 examined reading behavior and retention by ESL students and Experiment 4 looked at reading and retention by native English speaking students. In these three studies, the contrast was between retention of four major points when they were each marked by the presence of an enumeration term versus when they were not marked. In an additional study of reading and retention (Experiment 5), we examined the effect of enumerating some but not other major points within the same text.

Materials

The materials for the Experiment 1-4 were identical. Sixteen introductory texts containing instances of enumerated items were drawn from the following domains: cultural anthropology, geography, sociology, economics, psychology, oceanography, political science, biology, physical geography, and film studies. The texts were then modified to reflect four conditions that varied in their use of signalling devices. After modification, all passages were between 350 - 450 words in length, contained 19 or 20 sentences, and ranged in

difficulty level from grade 10 thru 12, with two at the grade 8 level, according to the Flesch Reading Ease Grade equivalent index.

There were four signalling conditions for each passage. All four versions had the same title, began with the same three introductory sentences, and concluded with the same three sentences. A sample text is shown in Table 9. The four signalling conditions were as follows.

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Insert Table 9 about here

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1. Full signalling (Full): The topic sentence in the passage explicitly cued the number of target points to be discussed. Then the first target point was given and was explicitly marked by the word *First.* This sentence was followed by two sentences that elaborated it. The next target point followed and was explicitly marked by the number word *Second.* It, too, was elaborated with two sentences. Similarly for target points three and four.

2. Topic sentence enumeration cue (Number): The topic sentence explicitly cued the number of target points to be discussed. However, within the body of the text, the individual points were not explicitly marked, i.e., the words *first, second, third* and *fourth* did not occur in the text. Otherwise the text in this condition was identical to the Full version.

3. Vague enumeration cue (Vague): This condition was identical to condition 2 except that in the topic sentence a vague quantity term was used instead of the specific number, e.g., <u>several</u> appeared in place of the word <u>four</u> in the topic sentence.

4. No signalling (None): In the fourth condition, the topic sentence contained no reference to the number of points to be discussed. The body of the text was identical to that appearing in the Number and Vague conditions.

Experiment 1 involved the collection of normative, rating data on the passages. The results of this study, which is fully described in Goldman (1988b), indicated that idea development was easier to follow in the Full signaling passages, and that they were more comprehensible than passages in the other three conditions. On the other hand, ratings of ease of understanding the vocabulary did not differ, consistent with our hypotheses about the locus of sequence marker effects.

Experiment 2: Effects of Sequence Markers on Recall by Native English Speaking Students

The purpose of Experiment 2 was to examine the effects of signalling on information retention. Retention was measured by recall of the target points in the passages in response to a probe-sentence cue. It was expected that recall of target information would be greatest for texts presented in the Full signalling condition; that the Number topic sentence condition would be superior to the Vague; and, that each of these would be better than None, in which there was no signalling of the target points.

Method

Subjects

Thirty-two introductory Psychology students participated in the experiment as part of the course requirement. All were native English speakers.

Materials, Design, and Procedure

The 16 passages used in Experiment 1 were divided into two sets using a matched pairs procedure and the data from Experiment 1. Four versions of each passage were assigned to four different booklets using a Latin Square counterbalancing procedure to insure that each booklet contained two instances of each condition. Across booklets and across subjects each passage occurred in all four conditions an equal number of times and each subject received two different passages in each condition. The design was a mixed

design with set the between-subjects factor (2 levels) and signalling condition the within-subjects factor (4 levels).

In addition to the eight experimental passages, each booklet contained one practice passage that contained no signalling. Subjects were told to read the passages carefully because they would later be asked to recall the information. The task was illustrated with the practice passage. The topic sentences from the None condition were used to cue recall of the target points, e.g., In the passage about the Ideal State, what were the basic issues that concerned Plato? Recall was done after every four experimental passages. Subjects were run in small groups in sessions lasting 1.5 to 2 hours. Details of scoring can be found in Goldman (1988b).

Results and Discussion

The results of ANOVAs on target point recall in each condition, treating subjects as a random factor, are reported here; analyses treating passage as a random factor are reported in Goldman (1988b). Treatment condition was the within-subjects variable and passage set was the between-subjects variable. Effects or interactions that are not reported were nonsignificant.

For target point recall, there was a main effect of signalling condition, F (3, 90) = 10.47, $p < .001$, $Ms_{error} = .567$. The means for the signalling condition effect are shown in Table 10. Four post-hoc contrasts on the signalling effect were done and the Bonferroni procedure was used to control for the Type I error rate (for four contrasts alpha level = .0125 per contrast). Target point recall was significantly better in the Full signalling condition (M = 2.5 out of 4) than in the other three (M = 1.65), F (1, 90) = 30.5, $p < .001$. Recall in the Full condition was greater than in the Number (M = 1.73) condition, F (1, 90) = 8.36, $p < .01$.

Insert Table 10 about here

Despite the nonsignificant pairwise contrasts comparing Number, Vague, and None conditions, the data in Table 10 indicate that these means were ordered in the predicted direction. That is, recall was somewhat higher in the Number condition than in the Vague and None conditions and the Vague condition was slightly better than the None condition.

Thus, as predicted, target point retention was better if passages contained explicit enumeration of the target information than if these signalling devices were absent. The pattern of data across the other three signalling conditions indicated much weaker effects of a signalling device that was present only in the topic sentence. Experiment 2 thus demonstrated the basic effect of signalling on retention. In Experiments 3 and 4 we pursued effects of signalling on reading behavior.

Experiment 3: Effects of Sequence Markers on Reading and Recall Behavior of ESL Students

The purpose of this study was to examine the effects of sequence markers on the recall and the reading behavior of ESL students. The experiment was identical in design to Experiment 2 except that students read the material one sentence at a time on a microcomputer screen. They were permitted to "flip" backwards and forwards through the text. We recorded this sequence of behaviors. Also, the time spent reading (viewing) each of the segments comprising the complete text was recorded.

Method

Subjects

Sixteen ESL students were paid $5 per hour to participate in the study. They were recruited from ESL courses at a university in Southern California. The courses from which the students were recruited are at the intermediate level of English language skills and students represented a range of language backgrounds. For additional information on the characteristics of the students, refer to Goldman (1988b).

Materials, Design, and Procedure

The passages were the same as those used in Experiment 2. They were again divided into two sets, each set containing 8 passages. Thus, there was one between-subjects factor (passage set) and signalling condition (4 levels) was the within-subjects factor. Dependent measures were number of target points recalled, reading rate per word and processing time per word. The rate and processing measures were computed over the entire passage as well as over the specific target point sentences.

Students viewed each of 8 passages, one sentence at a time, on a Macintosh Plus microcomputer screen. Specially developed software, **Readit!**, recorded the amount of time spent on each sentence and tracked the subjects forward and backward movement through the sentences in the text (Saul, Pohl, & Goldman, 1988). As in Experiment 2, recall followed four texts and was cued by the topic sentence from the None condition. Students were tested individually in sessions lasting approximately 2 hours.

Results and Discussion

Recall

ANOVA on the mean number of target points recalled (max = 4) indicated a significant effect of condition, F (3, 42) = 8.14, $p < .001$, $Ms_{error} = .447$. The means for the condition effect are shown in the middle panel of Table 10. Post-hoc contrasts indicated that Full signalling led to greater recall than the other three conditions, F (1, 42) = 13.87, $p < .01$. Furthermore, Number lead to greater recall than Vague, F (1, 42) = 6.32, $p < .0125$. The Full and Number conditions did not differ.

Reading time

ANOVA on the mean rate per word measure indicated that there were no significant differences in rate across the four conditions, $F < 1$. Subjects read at a rate of approximately 600 milliseconds per word and all means were within 20 milliseconds of one another. The data are displayed in Figure 1. For the mean processing time measure, also

shown in Figure 1, there was again no effect of condition, F (3, 45) = 1.24. Subjects spent an average of almost one second per word. A second set of analyses specifically compared the processing time per word in the target point sentences when they were signalled and when they were not. In the Full condition, the mean process time per word was 1.25 and in the None condition it was 1.06 seconds; this was a nonsignificant difference F (1, 15) = 3.05, p = .1. Despite the lack of statistically significant differences on the processing time measure, the magnitudes of the means are in the predicted direction and are consistent with the pattern of recall effects: Students spent the longest on passages with Full signalling and spent the shortest amount of time on the passages with Vague or No signalling.

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Insert Figure 1 about here

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Thus, predictions regarding the effects of explicitness of marking on recall of the target points were confirmed for the ESL students. When the specific number of points was cued (Full and Number conditions) recall was better than when vague or no information was given regarding the number of points to be developed in the text. Predictions regarding reading behavior were only weakly supported in that the reading rate data indicated no differences among the four conditions. The processing time data suggested a tendency for students to spend more time on the passages with explicit signalling, and specifically on the target points.

Experiment 4: Effects of Sequence Markers on Reading and Recall Behavior of Native English Speaking Students

This study was an exact replication of Experiment 3 except that monolingual, native English speaking students served as subjects.

Method

Subjects

Sixteen native English-speaking students enrolled in an introductory Psychology course participated in the study. Instead of monetary payment, these students received credit toward their course requirements.

Materials, Design, and Procedure

The passages, design, procedures and scoring were identical to Experiment 3.

Results and Discussion

Recall

ANOVA on the mean number of target points recalled (max = 4) indicated a significant effect of condition, F (3, 42) = 6.38, $p < .01$, $Ms_{error} = .358$. The condition means are shown in the third panel of Table 10. Post-hoc contrasts indicated that Full signalling (M = 3.13) lead to greater recall than the other three conditions, F (1, 42) = 17.31, $p < .001$. The other three conditions did not differ from one another (M = 2.41), Fs <1. Recall in the Full condition was better than in the Number condition, F (1, 42) = 7.06, $p < .0125$. Thus, as predicted, recall was better the more explicit the signalling.

Reading Time

ANOVA on the mean rate per word indicated a significant effect of condition, F (3, 45) = 3.18, $p < .05$, $Ms_{error} = 8$. Post-hoc contrasts indicated that in the Full condition, significantly more time was spent on each word read (Mn = 468 milliseconds) than in the other three conditions (M = 397 milliseconds), F (1, 45) = 7.63, $p < .01$. The Number, Vague and None conditions did not differ from one another. These means are shown in Figure 2. Similarly, ANOVA on process time per word indicated a significant effect of condition, F (3, 45) = 3.58, $p = .02$, $Ms_{error} = 16$. Contrasts on these means indicated that in the Full condition significantly more time was spent on each word (M = 662 milliseconds) than in the other three conditions (M = 575 milliseconds), F (1, 45) = 5.63, $p < .025$. Process

time per word in the target sentences was longer when they were signalled (M = .834) than when they were not (M = .634 in the None condition), F (1, 15) = 5.23, p = .04. The reading rate and processing time data indicate trends in the predicted direction: the more explicit the signalling, the slower the subjects' rates of reading and the more time they spent on the passage .

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Insert Figure 2 about here

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The performance patterns indicate that the primary locus of the effect of number signals is on attentional allocation during reading for the monolingual English speakers: in the Full condition the passage was processed more than in the Number condition and there was greater recall in the Full condition. That the Number and Vague conditions did not differ significantly suggests that when the signalling merely provides a criterion for recall completion, retention by native English speakers is not substantially enhanced.

Experiment 5: Linguistic Proficiency and the Effects of Sequence Markers on Strategic Reading Behavior and Recall

This experiment pursued two issues suggested by our earlier results. The first issue concerned the role of linguistic proficiency in the effects of the markers on recall. Essentially, we were interested in whether there were differences related to linguistic proficiency in the ability to use sequential markers to aid in retrieval of the signalled information. Accordingly, we sampled two levels of linguistic proficiency among nonnative speakers of English. The second issue concerned the more direct examination of the role of the sequence markers in comprehension monitoring. Within the same text, some sentences were marked with sequence terms while others were not. The specific predictions were that backtracking in the text would be related to disjunctures in the enumeration of four target points in the text. For example, in one condition, the first and third points in a four point text were preceded by the words *First* or *Third*, respectively. When the student reads

"Third,....." if they were monitoring their understanding, they should have backtracked to try and find the second point. This backtracking should occur if readers use the enumeration signals to aid their construction of an internal representation of the text and if they have not already coded a second point. That is, readers with sufficient skill may recognize the second point even without an explicit marker, and thus absence of the explicit marker would not affect their reading behavior.

Method

Subjects

There were 32 monolingual native English speakers and a total of 32 ESL speakers who participated in this study. These students participated as part of a requirement in their introductory Psychology course. The ESL speakers consisted of two proficiency levels, with 16 students at each group. ESL 2 consisted of students who were taking the two most advanced courses in the English language ESL sequence. ESL 3 consisted of 16 students who were enrolled in the two lower level English language courses in the ESL sequence. A variety of native languages were represented by the students in each of the ESL classes. Asian languages accounted for 88% of the ESL 3 and 38% of the ESL2 students; European languages accounted for the remainderof the students. The majority of students in all of the language groups were freshmen and sophomores

Materials, Design and Procedure

The materials were the passages used in Experiments 1 - 4, modified to implement the manipulation of the location of the sequence markers. There were again four conditions, but they differed from those used in the previous experiments. Specific to this study were the following conditions:

1. In the Number-Only condition, the topic sentence gave the specific number of points but none of the target points were signalled in the text. This condition was comparable to the Number condition of Experiments 1 - 4.

2. In the Number - 1 & 3 condition, the topic sentence gave the specific number of points and only the first target point and the third target point were signalled by the word *First* or *Third*, respectively.

3. In the Vague - 1 & 3 condition, the topic sentence used a vague numerical term (e.g., several) to indicate how many target points there were and only the first target point and the third target point were signalled by the word *First* or *Third*, respectively.

4. In the Vague - 2 & 4 condition, the topic sentence was the same as in the Vague 1 & 3 condition but only the second and fourth target points were signalled by the word *Second* or *Fourth*, respectively.

Details of the procedure were similar to that described for Experiments 3 and 4, with subjects reading two passages in each condition. In addition to the variables described for those experiments, there were three levels of linguistic proficiency, native monolingual English, ESL2, and ESL3. Dependent measures were number of target points recalled and processing time for the entire passage and for the specific target points.

Results and Discussion

Of primary interest was whether target points were recalled better when they were signalled as compared to when they were not. Performance in the Number - Only condition provided "baseline" data on recall of the four points when none were signalled. Table 11 provides the mean recall by each language group of each target point in three conditions: Unsignalled when no points were enumerated (Number-only condition), Signalled (enumerated points from the other three conditons), and Unsignalled (points that had not been enumerated in the other three conditions). The recall data from the Number-only condition were submitted to a multivariate, repeated measures Anova in which language group (Native English, ESL2 and ESL3) was the between subjects factor and target point (1, 2, 3 or 4) was the within-subjects factor, consistent with predictions, the results of the Anova indicated no differences in recall among the four points, $F(3, 59) < 1$. Language

proficiency had a significant effect on performance in this condition, F (2, 61) = 3.83, p < .03, MS_{error} = 1.012. The ESL2 group (M = 1.1) recalled significantly more than the ESL3 group (M = .61), but the native English students recalled the same amount (M = .91) as each of the ESL groups, Tukey-Kramer procedure critical difference = .60. Note that this group of native English speakers generally performed more poorly (M = 46% of the target points) than their counterparts in Experiments 4 (M in Number condition = 64%) but at about the same level as the students in Experiment 2 (M = 43%). The ESL2 group performed at a roughly comparable level (55%) in the present case and in Experiment 3 (61%).

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Insert Table 11 about here

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For comparisons of signalling effects within a passage, we used the recall data from the Number -1 & 3, Vague -1 & 3 and Vague -2 & 4 conditions. In the passages in these conditions, half the target points were enumerated and half were not. For each subject we constructed a mean for each target point when signalled and a mean for each when unsignalled by averaging appropriately over the three conditions. For example, recall for target point 1-signalled was the average of point 1 recall in two conditions: Number - 1 & 3 and Vague -1 & 3; target point 1-unsignalled was derived from recall in one condition: - Number - 2 & 4. Similarly, the data on target point 2-signalled were based on performance in the Number - 2 & 4 condition; target point 2-unsignalled was based on average recall in two conditions: Number -1 & 3 and Vague - 1 & 3. These derived data, shown in Table 11, were submitted to a multivariate repeated measures Anova in which language group was the between-subjects and there were two within-subjects factors: signalled/unsignalled and target point (1, 2, 3, or 4). The only significant effect was language group, F (2, 61) = 5.46, p = .01. Mean recall by native English (M = .93) and by the ESL2 (M = .94) groups did not differ but was higher than recall by the ESL3 group (M = .60), although the

differences failed to exceed the Tukey-Kramer critical value of .6, $p < .05$. It is interesting to note that the patterns reflected in the means in Table 11 suggest that marking was more important for the second and fourth points than for the first and third in the two more English-proficient groups of students. The processing time data indicated a similar pattern of suggestive but nonsignificant results.

Given these results, we did not pursue analyses of the reading behavior. Although the manipulation of signalling instantiated in this study failed to show the predicted effects, we believe that with longer texts and/or more complicated information, we might well observe the predicted marking effect within passages.

General Discussion of Sequence Marker Studies 2 - 4

The monolingual, native English speakers in Experiments 2 and 4 showed the same pattern of effects for the sequence marker variable: Whether passages were presented in booklet or computer form, the Full signalling condition produced the highest recall of the targeted information. The ESL students' performance was also consistent with our predictions: recalling the most from passages presented in the Full signalling condition. However, patterns of significant differences among the four conditions appeared to differ somewhat for the native English and ESL students and imply differences in the primary locus of the effects of these signals. For the native English speaking students in both experiments, recall was significantly better in the Full condition than in the Number condition but the Number and Vague conditions did not differ. At the same time, the more explicit the signalling, the longer the native English speakers spent reading the passages. This pattern suggests that for the native English speakers, the primary locus of the signalling effect was on the amount of time they spent reading the passages; there was a weaker, secondary effect due to the provision of a criterion for recall completion. In contrast, for the ESL students retention in the Full and Number conditions did not differ significantly but the Number condition led to better recall than the Vague condition. The pattern for the ESL students

suggests that knowing how many target points to look for and subsequently recall was the primary locus of the signalling effect and effects on attentional allocation during reading were secondary.

However, the lack of a significant effect on attentional allocation in the reading of the ESL students and the presence of an effect in the native English speakers should not mask the fact that the ESL students spent almost a full second on each word whereas the native English speakers spent 33% to 50% less time on each word. The ESL students may exert very high levels of attention to any passage they read, regardless of how explicit the signalling. Because they are reading at what are essentially "ceiling" levels of attentional allocation, there may be no "room" for an effect of signals on reading time. For native English speakers reading these passages probably does not require maximum levels of attention and they can respond differentially to different levels of signalling. In fact native English speakers may become dependent on conventional graphic and linguistic signalling devices to the point where they pay attention only to information that is marked as important.

Although the retention performance of both native English and ESL students was better the more explicit the signalling in the passage, the precise nature of the effect of signals appears to be different for the two groups. For the ESL students, the signals apparently had little effect on their reading but may have provided them with a criterion-cue, i.e., the number of points, that was useful during encoding and/or retrieval. There are two aspects of the data in support of this claim: (1) the amount of time spent processing enumerated points was not different from that spent on unenumerated points, and (2) when the topic sentence gave the specific number of points (Full and Number conditions) recall was equal and exceeded recall when there was only a vague or no indication of the number of points. In contrast, the signals primarily affected the reading behavior of the native English speakers. Having a criterion-cue in the absence of specific signals to the points was not

effective with these students. Unless they read the target points longer, recall was equal. The data in support of this claim are (1) native English speakers spent more time processing target points when the specific points were enumerated compared to when they were not enumerated, and (2) recall when the topic sentence gave the number of points but the points themselves were not enumerated was lower than when they were enumerated. Thus, for the native English speakers the signals appeared to foster selective attentional focus during reading; the criterion-cue value of the signals was weak. On the other hand, the ESL students may have been relying on the criterion-cue value as a check on whether they had gotten from the text what they should have. They read the text nonselectively until they had four points from the passage. Regardless of the different foci of the signalling effects, the present research indicates that the presence of enumeration signals improves the retention of the marked information for both native English speakers and speakers of English as a Second Language.

Analyses of the Reading Strategies of Native English and ESL Speakers

The procedures used in Experiments 3 & 4, yielded a trace of the sequence in which the passage sentences had been read by each student. We used these traces to examine the strategies students were using when they read the sequence marker passages. We were particularly interested in whether the strategies used by native English speakers were different from those used by the ESL speakers. From the traces created by the **Readit!** program, we characterized the reading strategies that students were using. Initially, we undertook these analyses expecting that there would be differences in strategy related to the manipulations of the sequence marking in the passages. This turned out not to be the case for the most part. Furthermore, native and nonnative English speakers were far more similar in their strategy profiles than they were different. However, several interesting findings emerged regarding the identification of reading strategies, variability within individuals and

between-group comparisons. (For a more extended discussions of this work, refer to Goldman, (1988c)).

From the traces of students' reading behavior, we identified three types of global strategies and a variety of local strategies. The global strategy *Once Through*, shown in Figure 3, is a straightforward, sequential reading of each sentence in the text from start to finish. The other two global strategies each involve going back and rereading various sentences in the text. The *Review Strategy*, shown in Figure 4, involves a straight through read of the passage to the end (as in *Once Through*), followed by rereading of some or all of the passage. The third one, the *Regress Strategy*, (Figure 5) involves backtracking prior to reaching the end of the passage on the first pass through it. After rereading the end of the passage, there might be backtracking and rereading of additional parts of the passage.

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Insert Figures 3, 4, 5 about here

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The eight passages of each of the subjects in Experiments 3 and 4 were classified as one of the three types of global stragegies and proportions for each subject of each strategy type were computed. With respect to the issue of whether different strategies were associated with the different signalling conditions, there was no effect of condition. That is, of the total number of passages that were read with a *Once Through* strategy, they were spread evenly across the conditions; similarly for *Review* and *Regress*. This was true for both ESL and native English readers. Figure 6 shows the mean proportion of passages in each strategy type for each language group. Both ESL and Monolingual English students most frequently used the *Regress* strategy- - backtracking during initial reading of the passage. The ESL students were somewhat more likely to use the *Review* strategy; the native English the *Once Through* strategy. However, all but one student used more than one type of approach and about a third of the students used all three strategies.

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Insert Figure 6 about here

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Thus, the global strategy data indicate that all the students varied the way in which they read the texts. But this variation was not related to the structural manipulation that we had done: the *Regress* Strategy was just as likely for Full signalling passages as for No signalling passages. We pursued the reading strategies further for two reasons: (1) to determine if signals affected reading behavior at a more micro, sentence-to-sentence level, and (2) to determine what sorts of structural and semantic/conceptual characteristics of the passage were guiding the reading behavior.

To examine the more micro level, we identified ten local or backtracking strategies, as shown in Figure 7. These local strategies are ways of describing the reader's movement through the text on a sentence by sentence level and capture patterns of forward and backward movement through the text. The ten represent two dimensions of reading behavior: whether people read or skimmed and how much of the text they covered in the process of backtracking. In this figure, heavier lines indicate reading, lighter lines indicate skimming. Closed circles represent reading a single sentence.

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Insert Figure 7 about here

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The first four strategies (A, B, C, & D) reflect movement through the text in one direction over a relatively long string of sentences. Strategies A and B involve sequential movement through the passage over at least 15 consecutive sentences; A involves reading those sentences, B skimming. Strategy A implies a general desire to reread most of the text, either from beginning to end or vice versa. Strategy B was typically used to return to the beginning of the passage prior to going through it again from the beginning. Strategies C and D reflect the use of both reading and skimming over segments at least 12 sentences long. In C, readers skim one or more sentences, read a sentence, continue skimming one or more

sentences, then read a sentence. In D, readers skim one or more sentences, but read several sentences, before they resume skimming.

The other six strategies reflect backtracking in which readers reverse the direction of their progress through the text, using a combination of reading and skimming and covering relatively short runs of sequentially ordered sentences (2 to 11). Of particular interest is Strategy E, which we refer to as a local rereading strategy: the reader is reading along but goes back and rereads the prior sentence before continuing to read. Use of E suggests that readers need clarification of a just-prior sentence before going on in the passage.

The frequency distributions of the local strategies were similar for the two language groups and signalling conditions. However, the distributions varied with the type of global strategy. Figure 8 shows the distribution for the Review Strategy. The four single direction strategies - A, B, C, & D - accounted for 80% of the local strategies, indicating that backtracking behaviors that occurred after reading the passage through once tended to involve returning to the beginning or near beginning of the passage (data for B) and going through the passage again either by reading each sentence (data for A), or by selecting certain groups of sentences to read (data for D). Thus, even after getting through the passage once, additional inspection of the text did not tend to involve local rereading strategies that interrupted movement in a single direction (none greater than 10%).

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Insert Figures 8 & 9 about here

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In contrast, the local strategies used in reading Regress Strategy passages reflected a relatively high incidence of backing-up-to-go-forward, as shown in Figure 9. Prior to reaching the end of the passage, the local backtracking strategy - E - accounted for 55% of the backtracking for these passages for both ESL and native English speakers. On these passages, students appeared to be trying to resolve comprehension difficulties and coherence

relations prior to taking in additional new information from the passage. The strategy A frequency indicates that about 15% of the time the local backtracking occurred either at the beginning (first 4 or 5 sentences) or end of the text (last 4 or 5 sentences) and then students read straight through the remainder of the text. After the first time through the passage, the distribution of local strategies was quite variable but generally indicated a greater reliance on skimming the text, with selected rereading of sentences and segments of the text.

Although local strategy use was not specifically related to signalling condition, it was clear that the traces of the students reading behavior were an excellent vehicle for examining relationships among a variety of text characteristics and reading behaviors common to several local strategies. In particular, we were interested in which sentences initiated and ended backtracks. Initiations and conclusions of backtracks are reflected in direction changes in the reading traces. Locations of direction changes were characterized with respect to how they reflected structural and semantic characteristics of text. Structural aspects of text are things like beginning, ending, and explicit rhetorical markers, such as our enumeration terms. We were particularly interested in whether explicit enumeration of the target points was an important cue to backtracking. Semantic aspects refer to various processes that must occur to achieve coherence, e.g., resolution of anaphor, construction of bridging inferences, etc.

The types of sentences that initiated direction changes were similar for the ESL and Native English speakers but differed across the global strategies. For the *Review* strategies, about 70% of the direction changes were related to a structural characteristic of the text - reaching the end or beginning of the passage (Figure 10). The topic sentence and the target points accounted for less than 20% of the direction changes. However, and for the ESL student only, the tendency for target points to initiate direction changes was strongest if they were explicitly marked (Full condition).

Insert Figures 10 & 11 about here

For the *Regress* Strategy passages (Figure 11), direction changes that occurred before getting to the end of the passage were governed more by semantic than structural properties: about 60% of the target points initiating direction changes were in the unmarked conditions (Number, Vague and None). This trend was true for both the ESL and the native English speakers. For the *Regress* strategy passages, after reaching the end of the passage the first time, direction changes appeared to be related to more structural properties of the texts: about 50% were initiated by reaching the beginning or end of the passage. The structural cue of marking was important for the native English speakers: explicitly marked target points accounted for 60% of the direction changes cued by the target points. This tendency was not present in the ESL students' data.

Thus, the direction changes were cued by structural and semantic properties of the texts, depending on the particular global strategy that the students were using. We also found that both structural and semantic aspects of the text were related to the sentences that students strategically selected to reread. These data are shown in Figure 12 for passages read with the *Regress* Strategy. About 65% of the sentences strategically read before getting to the end of the passage the first time were in the introduction or were target points. Once again, explicit marking of the points was not necessary for them to be singled out for selective rereading. Furthermore, the points elaborating the targets were strategically reread almost as much as the target point. Because these elaborations were not structurally marked and are at the lowest level in a content structure, they imply strategic rereading guided by semantic concerns.

Insert Figure 12 about here

The strategy analyses indicate that ESL and native English speakers have the same pool of available strategies. Furthermore, they appear to select a range of strategies and the variables that govern their selection are similar. However, additional research is needed to explore more fully the processing and strategic mechanisms that underlie the observed strategies. Currently, Goldman and Saul (in progress) are pursuing additional work on reading strategies that will enlighten our understanding of the constraints and decision rules that govern students' selection of one strategy over another as related to syntactic and semantic features of the text.

IV. UNDERSTANDING THE USAGE OF CONNECTORS BY NATIVE ENGLISH AND ESL SPEAKERS

Sequence markers are but one type of connector used in writing a cohesive text or in generating a coherent representation of a text. Other types of connectors include **additive** terms that indicate elaboration or exemplification of already mentioned content, **causal** terms that indicate cause-effect or antecedent-consequent relations, and **adversative** terms that indicate that the new information contrasts with or contradicts previously presented information. In previous research with ESL speakers, MacLean and d'Anglejan (1986) examined connectors as one of a larger class of cohesive devices. They presented a rational cloze task to native English and ESL speakers: the deleted words were various types of cohesive terms, including a variety of connector terms. MacLean and d'Anglejan found that ESL speakers did not differ from native English speakers in their use of information from other sentences (across sentence information) to determine appropriate completions.

In three experiments, we used the rational cloze procedure in conjunction with a multiple choice response task to examine differences in difficulty among four types of connectors, namely additives, causals, adversatives and sequentials (Goldman & Murray, 1989). The studies compared the performance of native English speakers and several

groups of ESL students who varied in level of language proficiency in English. In the first experiment, we compared cloze task and verbal justification performance of monolingual, native English speakers and ESL university students. Success in the university setting is in part determined by the ability to learn from text and we were interested in the levels of proficiency with connectors that might be characteristic of this population. Based on the findings from Experiment 1 on differential difficulty among the connector types, the purpose of Experiment 2 was to determine if monolingual native English speakers' confidence in their answers also varied with connector type. Finally, in Experiment 3, a group of community college ESL students who were at lower levels of English language proficiency than the university students completed the rational cloze task, provided confidence ratings, and gave verbal explanations for their responses. The design of the three experiments can be understood by reviewing previous relevant research.

Language Proficiency and Connector Understanding

Passages vary in the degree to which the inter- and intrasentential relations contained therein are made explicit. In the absence of explicit signals to logical relationships we rely on a "conversational postulate" for text: we infer cohesion based on the default assumption that successive sentences are related, making use of other cohesion devices such as referential and lexical overlap (Halliday & Hasan, 1976; Kintsch & van Dijk, 1978; MacLean & D'Anglejan,1986). Connectors, or conjunctives (Halliday & Hasan, 1976), are a type of cohesion device that make explicit the logical relations among sentences. Common connectors are *and, but, however, because.* Connectors are of limited utility unless the reader understands how connectors function in text and the logical relationship each specifies. This aspect of language proficiency is particularly important to students who acquire English as a second language (ESL) and are attempting to learn from English language texts. Anecdotal reports from teachers of ESL students frequently indicate that learning the appropriate use of connectors is an extremely difficult aspect of the

English language. To a lesser extent, this can also be said of native English speakers. For example, in a study of good and poor readers, Bridge and Winograd (1982) reported that both groups found it more difficult to provide explanations for the appropriateness of cohesive ties that they established with connectors than those that they established with referential and lexical cohesion devices. However, good readers were better able to justify their responses than were poor readers.

Although Bridge and Winograd found that connectors were difficult to explain, good readers were better at explaining them than poor readers. There is also evidence that benefits derived from the explicit inclusion of connectors in texts vary with language proficiency. For example, Geva and Ryan (1985) found that positive effects of including connectors occurred for skilled and less skilled readers when the conjunctions were included and highlighted in the text but only for the skilled readers when the conjunctions were present in the text but not highlighted. Furthermore, Geva and Ryan (1985) found that the omission of connectors negatively affected less-skilled readers but had no effect on skilled readers.

A major limitation of prior research on connectors is the unsystematic and limited sampling of connectors. It seems reasonable that some interclausal and intersentential relations may be easier to infer than others and the benefits of including explicit connectors would therefore be differential. In addition, grammar textbooks for ESL students typically devote large sections to sentence and clause connectors, providing elaborate taxonomies of connectors. For example, Celce-Murcia and Freeman (1983) have provided a functional classification scheme for logical connectors that differentiates among four major types of connectors: additive, causal, adversative, and sequential. The first three typically relate to interclausal or intersentential relations. Additive relations are those that signal some form of elaboration of previous content (e. g., *In addition, That is*). Cause-effect or antecedent-consequent relations are signalled by causal connectors (e.g., *As a result, Due to*).

Adversative connectors signal contrastive elaborations (e.g., *However, On the contrary*). Sequential connectors are used to signal a more diverse set of logical relations and refer to the larger discourse context more often than do the other connectors. Sequential connectors are used to enumerate lists of items (e.g., *First, Second, Finally*), to mark a sentence that previews the remainder of the text (e.g., *In short*) or to indicate temporal sequence of events (e.g., *Subsequently, Later*).

Accordingly, in this phase of the project, three experiments were conducted to investigate two primary questions: (1) whether the four types of logical connectors were differentially difficult for readers to understand, and (2) whether ESL speakers' understanding of connector usage was different from that of native English speakers. With respect to the first question, our expectations were that sequential connectors would be more difficult than the other three types of connectors for all students because sequentials generally require reference to the more global discourse context whereas the other three do not. Among the other three connector types, all indicate some form of continued elaboration of previous information. However, they differ with regard to what they signal is the connection of new to previous information, with causal and adversative connectors signalling more specific logical relations than additives. The latter indicate only that the next piece of information adds "in some way" to the previous information. In contrast, as noted previously, causal and adversative connectors, respectively, signal causal or logical contingency or contrast between old and new information in the clauses joined by the connectors. Predictions about the relative difficulty among these three connectors were not made.

We expected that ESL speakers would less frequently supply the appropriate connector when compared to native English speakers. However, two issues were of greater interest than the overall level of performance. If the four connector types did differ in difficulty, was there similarity in the patterns of the native English and the ESL speakers?

Second, we were interested in the strategies used to arrive at connector choices and whether these were similar for native English and ESL readers, especially where differential levels of English language proficiency were present. We pursued the strategy question by focusing on whether response justifications reflected differences among the connectors that are cited by text linguistists, discourse analysts, and ESL teachers. We collected retrospective verbal reports from students explaining their choices. We expected that the native English speakers would be sensitive to the functional, semantic differences among the connectors and this would be reflected in their response justifications. However, we also expected ESL students to be aware of usage rules because they are specifically taught.

In all three experiments, subjects completed a rational cloze task that had multiple-choice response options (as opposed to free completion). Confidence ratings were collected in Experiments 2 and 3. Students provided explanations of their responses in Experiments 1 and 3. All native English speakers were drawn from the same population. The ESL speakers came from two populations that differed in English language proficiency levels.

Experiment 1: Effects of Connector Types on the Cloze Completions and Response Justifications of Native English and ESL Speakers

The purpose of Experiment 1 was to compare the performance of native English and ESL university-level college students on a rational cloze task that required them to distinguish among four logical connectors in choosing the most appropriate intersentential connector. The rational cloze procedure was applied to passages characteristic of introductory-level textbooks used in university settings. Our general prediction was that ESL students would make fewer appropriate choices than native English speakers. We expected the differential difficulty of the four types of connectors to be similar in each group of students. Finally, based on previous research we expected that ESL and native English speakers would be similarly aware of prescriptive rules on the usage of the various

connector types but that the ESL students would be less accurate in identifying where in text the various rules applied.

Method

Subjects.

Participants were 16 monolingual, native English speakers and 20 ESL speakers, recruited from undergraduate classes at a university in Southern California. The native English speakers were enrolled in Introductory Psychology and participated as part of the course requirements. The ESL students were enrolled in English-language classes specifically designated for nonnative speakers of English. Successful completion of these classes is a prerequisite to satisfying the university's General Education English requirement. ESL students who participated in this study were volunteers recruited from classes at three levels, but the majority (15 students) came from the class (English 1) one level below the university-required English class. ESL students were paid $5 per hour for their participation.

Several demographic characteristics were assessed using a questionnaire filled out at the beginning of the experimental session. A summary of information most pertinent to the present study is provided in Table 12. The native English speakers were largely college freshmen and sophomores and all spoke English as the native language. The mean verbal Scholastic Aptitude Test (SAT) Score of 526.8 indicates that these students were representative of the entering freshmen classes at this university over the past several years. The ESL students were largely freshmen and sophomores. The native language of 70% of the ESL students was an Asian language (Chinese, Vietnamese, Japanese or Korean). The verbal SAT scores for the ESL speakers are typical for this population. Performance on the Test of English as a Foreign Language (TOEFL) is the language proficiency indicator typically used in making admissions decisions. The mean score of 564.7 is representative of students from non-English speaking countries who are admitted to the university.

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Insert Table 12 about here

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Design and Materials

The design was a mixed factorial with one between-subjects factor (native English or ESL language group) and one within-subjects factor (connector type). There were four levels of connector type: additive, causal, adversative, and sequential. Each connector type was the correct response twice in each of 4 passages for a total of 8 observations per subject on each connector. In addition to examining the number correct, we asked subjects to explain their choices for two of the passages. Passages were presented in four different orders, according to a Latin-square design. Within each language group, each presentation order was used an equal number of times.

Passages. Four passages from college-level, introductory science and social science textbooks were modified to accommodate 2 instances of each of the connector types. The mean number of words per passage was 488 and the mean number of sentences was 32.75. The passages were about biological characteristics of life, anthropological approaches to the study of culture, oceanographic explorations in the nineteenth century, and the societal functions of marriage. For purposes of illustrating the task to subjects, an additional, shorter passage (about the movie industry) was developed.

Subjects' task was to read each passage and to choose an appropriate word to fill in each of the cloze slots (represented as blanks) that occurred throughout the passage. Each cloze slot occurred at the beginning of a sentence and four alternatives were provided. Each half of each passage had four slots in it and each slot required a different connector type as the correct answer. A minimum of one complete sentence separated successive slots. The alternatives were instances of the four connector types; the correct response for each cloze slot was determined by the experimenters. That the experimenter-designated response was the best choice for the slot was verified by a panel of three independent judges, one of whom

is an ESL specialist. The order of the alternatives was systematically varied so the correct choice occurred in each position (1, 2, 3, or 4) an equal number of times. The order of the distractors was also varied so instances of the same connector type did not always appear in the same position.

Our classification of connector types and the specific instances used as response options were taken from the functional classification scheme proposed by Celce-Murcia and Freeman (1983) and based on the earlier work of Halliday and Hasan (1976). For the additives we used simple additive instances (e.g., *in addition*) and exemplification instances (e..g., *for example*); for causals, we used instances that signal cause/reason (e.g., *as a result*) and effect/result (e.g., *thus*). For adversatives we used instances that signal that two ideas are in contrast or conflict (e.g., *however*) and we used instances that signal a reservation or restriction in the applicability of the preceding information (e.g., *despite*). Sequential connectors featured the largest variety of subtypes and we used instances that signalled enumeration of points chronologically (e.g., *second*) or temporally (e.g., *next*) as well as those that indicated summation of information (e.g., *in short*).

The passages (including the practice passage) were arranged in a single "passage" booklet, and the alternatives for the slots for each passage were arranged in a separate "response" booklet. The order of the four passages was counterbalanced such that, across all subjects, each passage appeared in each position in the booklet an equal number of times.

Procedure. Subjects were run individually in sessions lasting 1.5 to 2 hours. Each subject completed a background questionnaire at the start of the session. After filling out the questionnaire, each subject was instructed on how to coordinate the passage and response booklets and worked through the practice passage during which time they could ask questions about the task. For each blank, subjects circled the best word to complete the sentence from among the four alternative words that were provided in the response booklet. Subjects were told that all punctuation associated with the alternatives had been

intentionally omitted, but that they could add any punctuation they felt was necessary to their response.

Following completion of the four passages, the experimenter re-presented the first two passages (excluding the practice passage) the subject had read. Subjects were told that we were interested in how they had decided on their answer and, in why they thought their answer was the best choice for the particular blank. For each blank, the students explained their reasons for selecting their alternative choices. This part of the session was audiotaped and later transcribed.

Scoring

Each subject received a score from 0 to 8, indicating the number of correct responses to the 8 cloze slots for each connector type. We determined the frequency with which each of the three distractor alternatives was selected incorrectly. For the incorrect responses we also examined the contingency relation between the correct connector and the type of distractor chosen. In the verbal reports, students tended not to described the process they went through in choosing the answer; rather they consistently described the type of relationship that held between the items of information that were being connected. To score these responses a set of 11 coding categories was developed. The categories reflect the previously discussed distinctions among the connectors; each coding category was appropriate for only one of the connector types. Interrater reliability in scoring the responses was better than 90%. Further details on the scoring are available in Goldman and Murray (1989).

Results

Correct Responses

The number correct for each subject for each connector type was subjected to a multivariate, split-plot ANOVA in which language group was the between-subjects factor and connector type the within. The means for each connector type and language group are

provided in Table 13. As expected, the main effect for language group was significant, F (1, 33) = 15.28, $p < .001$, MS_{error} = 5.02: The native English speakers were correct more often (M = 6.34) than the ESL students (M = 4.88). In addition, there was a main effect for connector type, F (3, 32) = 3.27, $p = .03$. Five post hoc contrasts, using the Bonferroni procedure (alpha level = .01), were conducted. Additives and causals were correctly answered more often than were adversatives and sequentials, F (1, 34) = 8.46, p = .006, MS_{error} = 6.69. The other four contrasts were not significant nor was the interaction between language group and connector type, F (3, 32) = 1.58.

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Insert Table 13 about here

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Distractor Choices

The correct response data indicated that the ESL speakers made more errors than the native English speakers - a mean of 12.2 per student (out of 32 possible) compared to 6.62. Regarding these errors, the following issues were of interest: (a) which connectors made the best distractors, i.e., were most frequently chosen, and (b) whether the distractors chosen by the two groups were similar. To investigate these issues, we computed the proportion of each subject's total errors that reflected each distractor option. The proportion data were subjected to an arcsine transformation and then submitted to a multivariate, split-plot ANOVA with language group the betwen-subjects factor and connector type the within. There was no main effect for language group, F (1, 34) = 3.04, p = .09. However, there was a main effect of connector type, F (3, 31) = 10.06, $p < .001$: Additives and causals were chosen significantly more often than adversatives and sequentials, F (1, 33) = 9.48, p = .004. There was also a significant interaction of language group by connector type, F (3, 31) = 4.69, p = .001. Table 14 gives the mean proportions for each distractor and language group. Examination of the means suggested that the interaction was due to differences in the magnitude of the differences among distractors.

Accordingly, three difference scores were computed for each subject in each group and the differences between the distractors were tested for significance, using the Dunn-Bonferroni procedure to control the Type 1 error rate (alpha = .017). Causals were chosen significantly more than adversatives by each group but the difference was larger in the native English speakers, t (32) = 2.83. The ESL speakers chose the adversatives and sequentials equally often but the native English speakers chose the sequentials more often than the adversatives, t (32) = 2.46. Although the means suggest that the native English speakers chose causals more frequently than additives while the ESL speakers chose additives more than causals, the difference between the groups failed to reach conventional levels of significance, t (32) = 1.88.

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Insert Tables 14 & 15 here

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An additional analysis pursued potential dependency relations between the errors and the correct connectors. The presence of a strong dependency, reflected by a dominant distractor for a particular connector type, would suggest some type of systematic misunderstanding of the meaning and usage of that connector. The proportions shown in Table 15 reflect the number of times each of the distractor options was chosen relative to the total number of errors on each connector. These dependency matrices indicate a relatively strong relationship between additive cloze slots and causal distractors for both the native English and the ESL speakers (probability of choosing a causal if an error is made on an additive cloze slot = .76 and .60, respectively). For each of the other connector types, incorrect responses tended to be split between two distractor options.

Both native English and ESL speakers were most frequently correct when additive or causal connectors were required by the text; they also choose these two types of connectors most often when they responded incorrectly, and there was some evidence of a dependency relationship between the additive cloze slots and the causal distractor. The

higher correct and distractor choice rates for the additives and causals suggest the possibility that subjects were generally biased toward choosing additive and causal terms. We examined this by determining the rates of choosing each of the four connector types as responses, regardless of whether the response was correct or incorrect. Then we determined the percentage of choices that were indeed correct. These data are presented in Table 16.

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Insert Table 16 about here

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According to the design of the passages, each connector should have been selected 25% of the time. The data indicate that the native English speakers and the ESL speakers selected the causals and the additives more frequently and the adversatives and sequentials less frequently than a "completely correct" response profile. However, the probability of being correct, given the choice of a particular distractor, was higher for the adversatives and the sequentials than for the additives and causals. It appears that both native English and ESL students have a more stringent set of constraints governing the appropriateness of adversative and sequential terms than those that govern additive and causals.

Justifications for Choices

Justifications for Choices that were Correct. Table 17 indicates the distribution of correct-choice justifications over the coding categories. The proportions were computed separately for each connector type, using the total number of justifications for the specific connector as the base. There are several interesting aspects of these data. First, the distribution of justifications for the ESL students is highly similar to that of the native English speakers: for each connector type, the proportional distributions over the coding categories for the connector reflect the same pattern. When there was a dominant response, as in the case of the causals, the adversatives, and the sequentials, the proportions for the ESL and the native English speakers were almost identical. Second, for the adversatives and

the sequentials over 95% of the justifications were accounted for by connector-appropriate categories. The proportion of connector-appropriate justifications was somewhat lower for the additive and causal connectors, although more than 75% were in connector-appropriate categories.

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Insert Tables 17 & 18 about here

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Justifications for Choices that were Incorrect. The distribution of the justifications for incorrect choices are shown in Table 18. The confusions among connectors that were reflected in the contingency analysis of the errors (Table 15) were generally reflected in the justification data. When students were justifying incorrect responses that had been made to additive slots, the majority of the justifications were in categories appropriate to causal connectors. This is consistent with the data showing that causal distractors were the most frequently chosen for additive slots. The most frequent justifications for incorrect choices for causal slots were in categories appropriate for additive connectors, with the remaining responses distributed over the causal-appropriate, adversative-appropriate and miscellaneous categories. The additive and causal distributions for native English and ESL speakers were highly similar.

There were some differences between the language groups in the distributions of justifications for incorrect responses made to adversative and sequential slots. For adversative slots, the native English speakers used categories appropriate to the causal 56% of the time and categories appropriate to the additive 13% of the time. In contrast, the ESL students used causal- and additive-appropriate categories equally often (34% each). The native English speakers' justifications of incorrect choices for sequential slots tended to be in causal-appropriate categories most frequently and additive-appropriate or sequential-appropriate categories equally often (24% each). On the other hand for incorrect

sequentials, the ESL students used additive-appropriate categories most frequently, causal-appropriate less often, and rarely used sequential-appropriate justifications.

The distractor dependency analysis and the justification data considered separately suggest that errors may be due to a "fuzzy" understanding of certain of the connectors. To more precisely pursue the source(s) of difficulty on items that students answered incorrectly we examined the relation between the justification and the connector selected. Three relations are informative with respect to source(s) of difficulty and these are illustrated in Figure 13. The first relation - incorrect alternative but a justification appropriate to the alternative chosen - indicates that the error is due to difficulty processing the information in the text: the student has selected the connector that matches the relation extracted from the text but it is not the logical relation actually called for by the text. For example, students' understanding of the text may have made them think that a causal connector was needed in an additive slot; students chose the causal and explained their choice using a causal-appropriate justification. Thus, they supplied the right connector for the wrong relation. This was the dominant pattern for both the native English speakers (63% of 56 opportunities) and the ESL speakers (65% of 122 opportunities).

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Insert Figure 13 about here

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The second type of relation between the connector selected and the justification - incorrect alternative but with a justification appropriate to the cloze slot - implies difficulty with the meaning of the connector terms: the student has extracted the logical relation called for by the text but does not choose the connector that conveys that relation. For example, the student explained the (incorrect) choice of a causal saying that what was needed in the text was an additive connector. This pattern did not account for many of the errors: 16% for the native English speakers and 6% for the ESL. The third relation reflects problems in processing the text and in matching the connector terms with the

inferred relation. In this case, the student selected an incorrect connector and provided a justification that was appropriate to neither the selected connector nor the cloze slot in the text. This pattern accounted for a moderate amount of the native English speakers' responses (21%) and for a somewhat higher percentage of the ESL students' responses (30%).

Thus, difficulty extracting the appropriate logical relation is implicated as an important source of student errors: inaccurate inferences about the appropriate logical relation between information contained in successive sentences in the text accounted for the vast majority (95%) of the ESL students' errors and 84% of the native English students' errors. The data also indicate that a simple "lack of knowledge" of the functions and meanings of various connector-type instances was not a primary reason for incorrect responses.

Discussion

The results indicate that native English speakers correctly completed more of the cloze slots than did the ESL students. For both groups, the pattern of difficulty among the connector types was similar: cloze slots requiring additive and causal connectors were more likely to be filled in correctly than were cloze slots requiring adversative or sequential slots. This pattern of differential difficulty partially confirmed our expectations. Although we had expected sequentials to be the most difficult, we had not expected the adversatives to be as difficult as the sequentials. Justifications for correct responses were similar for the two language groups and reflected the distinctions among connectors that we had postulated.

When incorrect responses were made, differences, as well as similarities, emerged between the language groups and among the connectors. In general, when native English speakers were incorrect they completed the cloze slots with causal connectors whereas the general tendency for the ESL students was to choose additive connectors. When these choices were examined contingent on the correct response for the cloze slots, we found that when additives were the correct choice, both language groups had primarily chosen causals. Both

groups showed similar choices when they incorrectly responded to causal and adversative cloze slots. However, the two groups differed on their incorrect choices for sequential cloze slots, with the ESL students primarily choosing additives while the native English students selected both causals and additives.

In both the ESL and native English speakers, there were tendencies toward overuse of the additive and causal connector terms. And although students were correct most frequently on additive and causal cloze slots, when they did choose adversative and sequential instances, there was a high probability that these choices were correct. Taken together, these findings suggested the possibility that students' perceived confidence about the appropriate logical relationship and choice might be less when they chose additives and causals as compared to when they chose adversatives and sequentials. We pursued this issue in Experiment 2 by administering a confidence rating scale along with the forced-choice cloze task.

Experiment 2: Effects of Connector Types on Cloze Completions and Confidence Ratings of Native English Speakers

Experiment 2 tested the hypothesis that students would be more confident of adversative and sequential cloze slot completions than of additive and causal completions. This study also served as a replication of the basic findings of Experiment 1 with a new sample of native English speakers. The methods used were similar to those of Experiment 1, except that confidence ratings were made and no justification data were collected.

Method

Subjects

Thirty-two native English speaking undergraduates enrolled in an Introductory Psychology class at a university in Southern California participated in this study for class credit. The demographic data reported on the background questionnaire indicated profiles similar to those of the native English speakers in Experiment 1.

Design, Materials and Procedure

The materials and design were identical to those used in Experiment 1 with the addition of a confidence scale that was printed on every page of the response booklet. This scale was printed in number line form and ranged from 1 (very low confidence) to 7 (very high confidence). Beneath each number was printed a word reflecting the degree of confidence represented by that number. The procedure was similar to Experiment 1 except that all subjects were run together in a single group session and provided confidence ratings rather than justifications. The design was a within-subjects design in which connector type was a four-level factor.

Results

Correct Responses.

As in Experiment 1, the number of correct responses for each type of connector was computed for each subject. The results of a one-way, multivariate, repeated measures ANOVA indicated a significant effect for connector type, F (3, 29) = 8.86, $p < .001$. Four post hoc contrasts of the means shown in Table 19 were computed, using the Bonferroni procedure (alpha = .0125). As in Experiment 1, additives and causals were correctly answered more frequently than were adversatives and sequentials, F (1, 31) = 13.4, $p < .001$, Ms_{error} = 6.8. Causals were correct more frequently than additives, F (1, 31) = 8.02, $p = .008$, Ms_{error} = 2.43. The difference between adversatives and sequentials was not significant, F (1, 31) = 1.37. Also shown in Table 19 are students' confidence ratings for those items that were correct. A one-way ANOVA on the confidence ratings indicated a significant effect of connector type, F (3, 29) = 8.8, $p < .001$. Post hoc comparison of the additive and causal ratings with the adversative and sequential ratings confirmed our prediction: Confidence ratings were higher for correctly chosen adversatives and sequentials than for additives and causals, F (1, 31) = 23.75, $p < .001$, Ms_{error} = .771.

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Insert Table 19

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Distractor Choices.

As in Experiment 1, we computed the distribution of each subject's total errors over the distractor alternatives. These proportions were transformed using the arcsine transformation and submitted to a one-way, multivariate, ANOVA. There was a significant effect of connector type, F (3, 29) = 14.65, $p < .001$. The mean proportions and transformed values are provided in Table 20. Four post hoc comparisons (alpha = .0125) indicated that additives and causals were chosen as distractors more frequently than adversatives and sequentials, F (1, 31) = 44.85, $p < .001$, Ms_{error} = .772. Causal distractors were chosen more frequently than additives, F (1, 31) = 7.57, $p = .01$, Ms_{error} = .605. Adversative and sequential distractors were chosen equally often. Confidence in these incorrect choices was not significantly different across the four connector types, F (3, 60) = 2.16, $p = .1$.

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Insert Tables 20, 21 & 22 about here

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The results of analyzing the dependency between the correct connector types for the cloze slots and the type of distractor selected when errors were made are given in Table 21. The pattern replicates the pattern observed in Experiment 1. The causal connector was the dominant distractor for additive cloze slots and the distributions for the adversative and sequential cloze slots were virtually identical to those given in Table 15. The one difference between the results of the two experiments is that more adversative distractors were chosen in causal slots by the students in the second study. The selection rate data, shown in Table 22, indicated a bias toward causals in that 32% of the choices were causals; however, only 66% of those choices were correct. Adversatives and sequentials were chosen least

frequently but had the higher percent correct rates. Confidence ratings for correct responses were highest for the less frequently chosen connector types.

Discussion

The results of Experiment 2 replicated the findings of Experiment 1 and extended them by showing that students were more confident of cloze completions for adversative and sequential connectors. Adversative and sequential connectors appear to have more restricted and perhaps clearer usage conditions than do additives and causals. Causals and additive terms, such as *and* and *so* may be more frequent in everyday language and their usage may not always literally connote a highly restricted meaning compared to adversatives and sequentials; as a result, some of their more specific meanings may become "diluted" in text more so than the meanings of adversatives and sequentials. Students may choose additives and causals because they are more familiar in everyday speech, not because they are certain about their appropriateness in the contexts of written text. Hence, even when their choices are correct, students' confidence in additive and causal completions is weaker than their confidence in less frequently chosen adversative and sequential connectors.

These data provide support for the interpretation that although adversative logical relations and sequential temporal relations are less often constructed by students, when they are constructed, students are confident of the accuracy of their inferences. There is significantly more doubt when causals and additives are selected for use in a text. Experiment 3 pursued these issues with ESL students at generally lower levels of English language competency than the individuals who participated in Experiment 1. Because of this, we also used a new sample of texts appropriate to this population and a somewhat different set of connector terms.

Experiment 3: Effects of Connector Type on Cloze Completions, Confidence Ratings, and Response Justifications of ESL Students

The purpose of Experiment 3 was to examine whether ESL students confidence in their cloze completions varied with the type of connector. In addition, we were interested in testing the replicability of the ESL results from Experiment 1. Due to constraints on the ESL population in our locale, the sample for Experiment 3 was drawn from a local two-year, community college rather than from the university. Because this population is generally at lower levels of English language proficiency than the university population, we developed a new set of passages based on texts at the level of the students' proficiency in English. Thus, Experiment 3 was a replication/extension of the basic findings of Experiments 1 and 2 to both a new subject population and different materials. Data were collected on the cloze completion, the confidence rating and the response justification tasks.

Method

Subjects

Participants were 35 ESL students enrolled in the advanced-level ESL English course at a local community college. Nineteen of the students were enrolled in a course that met during the day and 16 attended a night class. All students in the class participated in the paper and pencil part of the task and it was conducted during class time. Following the group session, 8 students from the day class and each of the night class students were seen individually for purposes of explaining their response choices on the first two passages that they had read.

The ESL students in Experiment 3 were more heterogeneous than the ESL students who participated in Experiment 1. As is evident from the data in Table 23, the subjects in the present study were older and reflected a greater age range. They had taken fewer related courses and the level of English language skills ($\underline{M}$ = 5.3 grade level equivalent) was lower than for the ESL students in Experiment 1, who were reading at levels sufficient to enter the

university. In addition, all except two of the subjects for Experiment 3 had started schooling in English at age 12 and 50% had actually started at 18 years of age or later.

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Insert Table 23 about here

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Design and Materials

The design was a mixed factorial in which class (day or evening) was a between-subjects factor and connector type (four levels) was the within-subjects factor. Dependent measures were derived from the cloze completion responses, the confidence rating task and the justification data. Due to the generally lower level of English skill in this population of ESL students as compared to the university students of Experiment 1, new passages were developed. The same constraints on the occurrence of blanks and distribution of response alternatives described for Experiment 1 and 2 were followed in constructing the passages used in Experiment 3.

Passages. The four passages were modified versions of texts drawn from textbooks that had been used in the past by the ESL program at the community college but not by the particular students who participated in the study. We selected passages that dealt with fields in the social and natural sciences. Specifically, the following topics were discussed: life styles during the Paleolithic Age, emotions that cause laughter, the natural resources in Siberia, and the mystery of the Bermuda triangle. After modification to accommodate the connectors, the mean number of words per passage was 518 and the mean number of sentences per passage was 32.25. For three of the passages, the Flesch grade level equivalent was 9-10 and for 1 it was 7-8.

A passage booklet and accompanying response booklet were created for each subject. The passages were presented in four different orders to counterbalance position effects for the experimental passages. The practice passage was always the first one. As in Experiment 2, each page of the response booklet contained the four alternative choices for a particular

cloze slot as well as a confidence rating scale. The same constraints described for Experiments 1 and 2 on the ordering of the response alternatives were followed in this experiment.

Procedure

The subjects enrolled in the day class completed the passage and response booklets over a series of 4 class sessions, each session lasting for 55 minutes. The subjects enrolled in the evening class completed their booklets over a series of 2 class sessions each approximately 2 hours in duration. The procedure involving the booklets was identical to the one used in Experiment 2. After completing the booklets, a sample of 8 students from the day class were seen in individual sessions and asked to explain their response choices for the first two passages. Subjects were systematically selected so that a discussion of each passage occurred an equal number of times. All subjects enrolled in the evening class were interviewed.

Results

Correct Responses

The mean probability of correctly selecting each type of connector was computed for each student. A multivariate, split-plot ANOVA revealed no main effect (F (1, 33) = 2.93, $p > .05$) nor interaction ($F < 1$) involving the class variable. However, consistent with Experiments 1 and 2, there was a main effect of connector type, F (3,31) = 13.76, $p<.001$. Five post hoc comparisons were computed using the means shown in Table 24 and the Bonferroni procedure was used to control the Type 1 error rate (alpha = .01). Additives and causals were correctly chosen more frequently than adversatives and sequentials, F (1, 33) = 36.27, $p < .001$, Ms_{error} = .075. Additives and causals were not significantly different, F (1, 33) = 3.47; nor were adversatives and sequentials, F (1, 33) = 3.45. This pattern replicates the results obtained in Experiments 1 and 2: Responses for additive and causal slots were more often correct than were those for adversative and sequential slots.

Insert Table 24 about here

In contrast to the findings of Experiment 2, the ANOVA of the confidence rating data failed to reveal any significant differences due to connector type, F (3,93) = 2.19, p = .09, Ms_{error} = .24. Thus, the ESL students were no more confident of their adversative or sequential choices than they were of their additive and causal choices. Furthermore, their confidence ratings for their correct answers were about 1 scale value below the ratings of the native English speakers' confidence in their correct answers.

Distractor Choices

The proportion of each subject's total errors associated with each distractor alternative was transformed using the arcsine transformation and submitted to a multivariate, split-plot ANOVA in which class and connector type were factors. As in the analysis of the correct responses, there was no effect of class, F (1, 33) = 3.51, p = .07. There was, however, a significant effect of connector type, F (3, 31) = 20.77, p <.001. The means are shown in Table 25. Five post hoc comparisons, using the Bonferroni procedure (alpha level = .01), were conducted. Additive and causal distractors were selected more frequently than adversative and sequential distractors, F (1, 33) = 51.77, p < .001, Ms_{error} = .381. Causal distractors were selected significantly more often than additives, F (1, 33) = 13.23, p < .001, Ms_{error} = .24. The probabilities of choosing adversative and sequential distractors were not significantly different from one another; nor were the probabilities of choosing additive and adversative distractors. The distractor choice data replicate the findings for the native English speakers in Experiments 1 and 2 in that causals were the most frequently chosen distractor. For the ESL students in Experiment 1 there was a tendency to choose the additives and causals most often; thus there was a minor difference between the two ESL samples.

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Insert Table 25 about here

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ANOVA on the confidence ratings for the incorrect cloze completions revealed a significant effect of connector type, F (3, 29) = 3.96, p < .01. Post hoc contrasts indicated that confidence was higher for adversative distractors than for sequential distractors, F (1, 31) = 11.24, p = .002. Examination of the patterns of the means shown in Tables 24 and 25, the confidence ratings for the correct responses, suggested that there was a potentially interesting interaction between connector type and ratings for correct compared to incorrect choices. The ANOVA on these data indicated higher confidence when the correct alternative was chosen (M = 4.93) than when a distractor was chosen (M = 4.57), F (1, 28) = 14.29, p = .01. There was also a significant connector type by correctness interaction, F (3, 26) = 3.64, p = .02. The interaction was pursued with three post hoc contrasts (alpha level = .017). The significant contrasts indicated (1) that the difference between ratings of correct and incorrect responses was larger for sequential connectors than it was for the other three connector types, F (1, 28) = 8.63, p = .007, MS_{error} = 8.57; and (2) that correct selections of sequentials received higher confidence ratings than when sequential distractors were chosen, F (1, 28) = 17.33, p < .001, MS_{error} = .971.

The results of Experiments 1 and 2 suggested that both native English and ESL students often selected causal connectors when additives were most appropriate. In the present sample of ESL students, the dependency relation analysis indicated a much weaker relationship. As the data in Table 26 indicate, 50% of the distractor selections for additives were causals but adversatives were selected in almost 40% the cases. In addition, additive and adversative distractors were the most frequent distractors selected when errors were made on causal slots; finally, causals were the most frequently selected distractor for adversative and sequential slots. It appears that these ESL students who were at lower levels of English language proficiency had a strong tendency to overattribute causality.

Insert Table 26 & 27 about here

That there was a general bias toward selecting causal connectors is supported by the analysis of the connectors selected by the students. The data are provided in Table 27. First, 34% of the choices were causals, reflecting the tendency to choose causal alternatives. However, the likelihood that these choices would be correct was relatively low, 42%. Sequentials were least often chosen but had the highest likelihood of being correct. Additives were given the highest confidence ratings, in contrast to the pattern manifest by the native English speakers in Experiment 2. Thus, although the adversative and sequential alternatives were selected least often, they did not manifest the pattern of proportion correct and confidence ratings that prevailed in Experiment 2. Nor did the present sample of ESL students manifest the pattern shown by the ESL students in Experiment 1, wherein adversative and sequential alternatives were selected least frequently but were most frequently correct. It is possible that these ESL students who are at less sophisticated levels of Enlgish language training do not make use of the greater degree of constraint governing the use of adversative and sequential connectors. The verbal justifications were pursued to enlighten the criteria that these students were in fact using.

Justifications of Responses

Justifications for Correct Responses. Table 28 provides the proportion of responses in each of the justification categories for each of the connectors. Several trends are important. First, the majority of justifications for each of the connectors were in categories consistent with definitions and taxonomies of logical connectors, i.e. 60% or more of the responses were in connector-appropriate categories. Furthermore, the dominant responses within each category were consistent with the distribution obtained from the native English and ESL four-year college students in Experiment 1. Justifications for additive slots were divided between example and elaboration. The dominant justification for

causal slots was the existence of a cause-effect relation; the dominant justification for adversative slots indicated that comparison, contrast, or unexpected information was present. For the sequential slots, justifications involving new or next points or temporal relations were given. There was some difference between the pattern on the sequentials in this study and the patterns in Experiment 1; however, in designing the texts for Experiment 3 we purposely tried to use connectors that indicated temporal relations or "next" points. Thus, differences in the justification data for Experiments 1 and 3 are undoubtedly due to the specific passages and connectors we included in the materials.

There was one difference between Experiments 1 and 3 that was probably not due to the specific passages: Approximately 37% of the justifications for correct responses were in the Miscellaneous category and the majority of these were choice by exclusion, i.e., "The others didn't fit." The higher frequency of the exclusionary category suggests that the community college students may be operating with a greater degree of implicit or tacit knowledge about these connectors than are the university students. The former may be trying the alternatives to see which "sounds" best, relying on implicit knowledge in the process. This knowledge may be unavailable to them for verbalization.

Justifications for the incorrect responses. As with the justifications for correct responses, about 30% of the justifications of incorrect responses were in the miscellaneous category, with no difference between connectors in this trend. Consistent with the results of Experiment 1, the proportion of justifications for choices that were incorrect generally reflected the dependency relations that were reflected in Table 26. For example, 36% of the 44 justifications for incorrect causal-slot responses were additive-appropriate reasons and 18% were adversative-appropriate. For adversative slots, 27% were additive-appropriate and 27% were causal-appropriate categories. For incorrectly complete sequential slots, causal -appropriate explanations were provided 41% of the time. The additive slots where the only ones were subjects showed more than a slight tendency to use

connector-appropriate connectors: 23% of the justifications for incorrect responses were additive-appropriate.

The justification data were used in conjunction with the completion data to examine the source(s) of difficulty for these students. Of the three relations discussed in the context of Experiment 1, we found two of them to be equally likely in the data of the ESL community college students. For 48% of the justifications for incorrect responses, students used a justification appropriate to the distractor they had selected (branch 1 in Figure 13). This pattern implies difficulty understanding the relation called for by the text. An additional 45% of the justifications for incorrect responses used a justification that was inappropriate given the slot in the text and did not fit the distractor selected (branch 3 in Figure 13). This pattern implies difficulties both in processing the relations in the text and in understanding the meanings of specific connector terms. Justifications that were inappropriate to the choice but appropriate to the slot were relatively rare (6%) and indicated that knowledge of the specific connector words was not the major source of difficulty. Thus, the major problem seemed to be in processing logical relations in context and recognizing when the specific types of logical connectors were needed.

Discussion

The patterns of results in this study were generally consistent with our predictions and the results of those of Experiments 1 and 2. Cloze completion responses were more frequently correct for additive and causal slots than for adversative and sequential slots and justifications for the correct responses reflected the appropriate connector functions. However, contrary to expectations, the ESL students' confidence ratings for correct choices were equivalent to one another. When they were incorrect, ESL students most frequently chose causal distractors, although their confidence in these choices was not terribly high. The confidence rating data for the incorrect choices was unanticipated: they were more confident of wrong answers when they had chosen

adversatives and additives than when they had chosen causals and sequentials. Finally, the dependency relations between the correct cloze completion and the type of connector incorrectly selected, in conjunction with the explanations of the incorrect choices suggest that in this sample, the ESL students had a less precise understanding of the differences in meaning between frequently used causal expressions, such as *thus*, *so*, and *hence* and frequently confuse them with simpler additive or sequential indicators.

General Discussion of Connector Studies

In each of the three studies there was a consistent effect of connector type: when cloze slots required additive or causal completion terms, students were more likely to be correct than when adversative or sequential terms were needed. We had predicted that sequentials would be difficult because (1) there are a greater number of sequential subtypes and (2) correctly selecting one often requires a reference to the global passage rather than to the local clause or sentence context. We were somewhat surprised that the adversative tended to be as difficult as the sequential. We suggest three plausible explanations of performance on adversatives. The specific instances of the adversative may have lower frequency of use than the instances of additives and causals. Second, performance on the adversative may be affected by the existence of a reader consistency bias. That is, readers may be operating with a default assumption that favors interpreting successive sentences as elaborating on the old material rather than by contradicting it or restricting its scope. Finally, recognition of an adversative relation may require a more complex backward search to prior content than the causal or the additive.

The effect of linguistic proficiency on correct performance was consistent with our general expectations. ESL speakers were able to correctly complete fewer cloze slots than native English speakers; community college ESL speakers performed at lower levels than university ESL speakers. However, it is important that the connector type pattern was generally consistent across groups.

That there was a response bias toward the additive and causal instances was illustrated in two of the measures. First, causal and additive connectors were the most frequently chosen distractors. Furthermore, the student selection rate data showed a strong tendency to choose causals and additives. The selection rate analysis also showed that adversative and sequentials were more likely to be correct when they were selected, and students had the highest degrees of confidence in these, although this effect was not as strong among the least English proficient.

Analyses of the incorrect choices revealed some interesting information regarding intersentential reasoning and inference making. Causal distractors were particularly likely when students failed to choose the correct additive alternative. Justifications for these errors indicated that students had inferred a causal relation where an additive had been intended. The tendency to incorrectly choose a causal was present but at attenuated levels for the adversative and sequential slots. The strongest trend toward choosing the causal was present in the data of the community college ESL students.

The patterns associated with incorrect responding may reflect two influences. Readers may be using the causal in an effort to create relatively tight connections among units of information. Alternatively, conversational English may create a "sloppy" meaning for causal connectors such as *so, thus,* and *because.* That is, these terms may be used in situations where a relationship other than cause-effect is being discussed. They may serve as "psuedo bridges" rather than as true causals. As a result, greatest overuse of the causal would be expected for those students whose dominant experiences with English have been in informal, conversational contexts. Similar confusions in understanding the causal have been reported among children acquiring English as a first language (e.g., Corrigan, 1975). Content domain study demands more precision in the meaning of the language we use; connectors are no exception. Thus, as students engage in more interaction with formal text,

they are forced to refine their understandings of these terms and the usage constraints that govern them.

The relationship between incorrect responses and their justifications indicated that errors were predominantly due to incorrect inferences about the appropriate logical relation and an inability to find the connector that expressed those incorrectly inferred relations in context. When students had inferred the appropriate relation between sentences, they rarely erred in choosing the correct connector.

A major source of difficulty for students doing this task was inferring the appropriate relation between successive sentences. For informational texts such as these, designed with the explicit purpose of communicating new information to students, it seems particularly important to use logical connectors, especially when contrastive points are being made. It is also clear that in content domains where it is important for students to clearly distinguish between psuedo and true cause-effect relations, explicit connectors in the text will facilitate accurate understanding. We also want to emphasize that differences in performance between native English and ESL students were largely in overall levels of performance and were not primarily associated with differential patterns among the connectors. General content-domain comprehension skills, rather than specific connector skills, are therefore implicated as the locus of the language group differences. Once ESL students have grasped the basic meaning and functions of instances of specific connectors, further drills on isolated use of connectors are not likely to lead to improved performance on connectors in natural text contexts. Rather, improving ESL proficiency at this level seems to require instruction that fosters understanding logical relationships between sentences and how connectors signal such relations when those sentences occur in meaningful, content-domain contexts.

V. SUMMARY AND CONCLUSIONS

The research conducted under the auspices of this project generally indicates that there are more similarities than differences in the reasoning and comprehension processes of ESL and native English speakers. There were few differences found between language groups in the processes applied to answering questions, to reading and recalling information, and to constructing cohesion between sentences of a lengthy passage. Linguistic characteristics of text were found to affect those processes similarly, regardless of language group. Our comparative investigations revealed several interesting aspects of the nature of learner, task, and text interactions in text processing and we turn to a discussion of these here.

In the oceanography protocol study, differences between more and less successful learners were associated with domain-specific background knowledge rather than with English language proficiency. Those with greater knowledge of domain-related concepts performed better than those with a lesser knowledge base. We found that for both language groups, certain types of questions were more difficult than others. The more difficult questions were those that required application of information from the text to new situations and those that paraphrased statements in the text. The one difference we found between native English speakers and ESL speakers was that the latter tended to engage in more extensive text searches for purposes of both locating question-relevant information and for confirming answers. The ESL students' greater reliance on text searches emphasizes the importance of being able to thoroughly decode and process the linguistic form. But weaknesses in processing the text do not necessarily impair question answering: ESL students with high levels of domain-specific knowledge may compensate for less than perfect proficiency in English by activating knowledge of principles and facts relevant to questions, based on contextual cues discerned in the text and questions.

Finally, the protocols also revealed an interesting "impasse" that occurred when questions had a high number of words that matched the text: Both ESL and native English

students often engaged in lengthy text searches, as if they believed that the answer "was there somewhere." Particularly for questions requiring application or integration the simple search strategy did not produce the correct answer. Having engaged in a lengthy but unsuccessful search for the answer, students frequently gave up and did not answer the question. They rarely re-evaluated their approach. One implication of these impasses is that application questions should be indicated as such. It would undoubtedly facilitate learning, especially of ESL students whose dominant solution strategy is text search, to more clearly differentiate between questions that are answered "in the text" and those that require thinking "beyond" the text.

The oceanography protocols of both native English and ESL students indicated that they did not always capitalize on the linguistic devices that cue the organization of discourse. Our experimental studies pursued one class of such devices, connectors. As a group, connectors signal the logical relationships among clauses and sentences and they can be important cues to local and global discourse organization. The experimental studies indicated that native English and ESL speakers' ability to recall information was aided by the presence of sequential connectors. However, reading behavior appeared to be governed by a broader range of factors than the simple presence of a sequential marker. A broad range of semantic and structural factors appear to operate in concert as readers proceed through text. It will be important in subsequent research to examine these factors more precisely. The methodology developed in the present context is an important tool for pursuing these issues. The reading strategy analyses indicated that individuals used a mixture of strategies for reading text. ESL and native English speakers portrayed similar mixtures of strategies, although there was a tendency for the ESL students to review text materials more frequently than did the native English speakers. The more extensive processing of t ext in these studies replicates the similar finding in the oceanography study.

In our studies of four types of connectors, we again found that the general orientation to the task was similar for the native English and ESL students. Patterns of correct responding as well as of incorrect responding were consistent across groups. In all the language groups, but especially in the least English proficient ESL students, there was a tendency to overuse causal connectors. This tendency may reflect the influence of usage patterns in spoken English, where speakers often use causal terms even when a cause-effect relation is not intended. Errors were associated most frequently with inappropriate inferences about the logical relation between sentences; errors were not primarily due to incorrect understanding of specific connector terms themselves. One implication of this research is that the inclusion of connectors to signal intended intersentential relations is likely to facilitate appropriate understanding. The clear and explicit marking of the relation in this way is likely to benefit most those students for whom English language reasoning and comprehension are weakest.

ESL students appear to apply reasoning and comprehension strategies that are very much like those used by native English speakers. A range of text and task characteristics have been shown to similarly affect each language group. Despite the similarities, the ESL speakers were less efficient than the native English speakers. The ESL speakers took longer to complete every one of our tasks, even though they generally performed at lower levels. The costs associated with more laborious and effortful processing on the part of ESL speakers may affect motivation and general attitudes toward reading and schooling as well as the efficiency with which cognitive operations are performed . Motivational costs may manifest themselves in a reduction in perseverance when faced with assignments deemed difficult even for native English speakers. Furthermore, because ESL speakers, even at the university level, require more time per assignment than native English speakers, there are potential effects on the amount of work that can be accomplished in a fixed period of time and on the number of courses that can be

taken in any given school term. To enhance academic and economic performance of ESL speakers, important questions for subsequent research are those that inform our understanding of (1) cognitive, motivational and attitudinal costs of inefficient processing and (2) the development of efficient reasoning and comprehension in English ESL speakers.

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Table 1

Question types and distribution of experimental questions across types

1. Verbatim relationship between the question and the text.

2, 3A: "What are..."	properties of concept
12, 1A: "How many..."	quantitative response
12, 3A: "What fraction..."	quantitative response
12, 3C & D: "What (%)..."	quantitative response
12, 3E: "Does the difference (between quantities)..."	

2. Paraphrase relationship between the question and the text, including the necessity for vocabulary conversion and equivalence.

2, 1A: "How do we..."	
2, 1B: "Why ..."	
2,5: "How can..."	
12, 2A: "What is..."	quantitative response

3. Verbatim "look up" plus comparison.

12, 1B & C: "How does this compare..."	quantitative comparison
12, 2B: "How does this compare..."	quantitative comparison
12, 5: "How are...similar?"	concept comparison

4. Cross paragraph integration.

2, 3B: "Explain (properties)..."	concepts
2, 6: "Explain how..."	process
12, 4: "What is the difference between..."	concept comparison
12,6: "Explain why..."	concept and process.

5. Reasoning, application, computation questions.

2, 2: "How much..."	quantitative response. Formula; not all the necessary information is explicitly in the text.
12, 3B: "What..."	quantitative response. The next value in a series must be determined from the series. Alternatively, the rule that generates the values in the series is given in the text and may be applied (see 12, 3E) to extend the series.

Table 2

Subject characteristics

Learner	Major	SAT (V/M)	Native Language	Self-rating learning from lecture	Self-rating English text	Self-rating command of science vocab
HS[a]	Geology	NA	English	Extr. good	Extr. good	Extr. good
MR[b]	Physics	560/650	English	Good	Extr. good	Good
LH	Communications	990-both	English	Extr. good	Extr. good	Good
DW[c]	Sociology	550/590	English	Extr. good	Extr. good	Good
II	Bus./econ	380/540	Croatian	Good	Good	Moderate
EH	Bus./econ.	550/500	Dutch	Good	Extr. good	Moderate
GL	History	520/440	Spanish	Extr. good	Good	Moderate

[a]The teaching assistant for the course and a graduate student studying Oceanography.

[b]MR's background is heavily oriented to the hard sciences. He had already taken two other College level geology courses. In combination with his physics major, this background qualifies MR as a subject matter expert or near expert in the introductory course in Oceanography because many of the concepts and relationships were familiar to him from his other science courses.

[c]DW had had one year of foreign study in Chile and lists Spanish, French and Russian as other languages that she has knowledge of .

Table 3

Question Answering Model for Learning from Academic Texts

Processing Events	Goals
Encode Question	**Goal:** Determine the type of answer required by the question.
	Goal: Determine starting point(s) for searching for an answer.
Search Memory for Answer	**Goal:** Find a candidate answer that exceeds criterion for response. (Evaluate likelihood of success with continued search. If high, continue memory search; If low, try another means.)
	Goal: Determine alternate sources for answer. (Memory search may provide information that facilitates external search.)
Search External Source for Answer, e.g. Textbook	**Goal:** Delimit search space. (Use question and results of any memory search.)
	Goal: Find relevant information.
	Goal: Process the text information in the context of the task defined by the question.
Construct and Output Answer	**Goal:** Answer question completely.
	Goal: Match type of answer to type of question.
Metacognitive Processing,	
e.g., Confirm Answer	
Monitor quality of answer	
Self-Monitor	

Table 4

Natural language protocol for DW [a]

1. Explain why you feel cold when you get out of the shower.
   (Reading the question)
2. I think it's coming back to latent heat.
3. Explain why you feel cold when you get out of the shower.
   (Rereading the question.)
4. Because of the evaporation process.
   (Initial Answer)
5. But what is it that causes that?
6. Back to the book.
7. "Suppose we take a certain amount of water saturated air
8. and raise its temperature by one degree Celsius.
9. Some of the added heat would go into raising the temperature.
10. For example, because the water is saturated, increase...
11. We know that nearly twice as much added heat can go into evaporating water."
    (Lines 7 - 11: Reading S29=S32 in section B.2)
12. "Since the fas..."
    (Begins to read S15 in section B.2)
13. I'm thinking in my mind at the same time as I'm reading this
14. that I could simply say because the shower was so warm,
15. and you'd get out and the air temperature's not as warm as the shower,
16. but I know that there's something in the book that I'm missing.
17. Um, " 29% continents"
18. "remainder stored polar caps..."
19. "atmosphere loses..."
20. Oh, here we go.
21. "The ocean loses water but gains it back through precipitation,runoff...
    "*(Lines 17 - 21: Skimming from beginning of Chapter through section A.2)*
22. "Everyone is aware that the water in an open pan will slowly evaporate.
23. The warmer and drier the air,
24. the faster the water will disappear.

(table continues)

Table 4 (continued)

25. The amount of water the air can hold depends on ....
(Lines 22 - 25: Reading S1, 2 , 3 under B.1)
26. "room temperature..."
27. "several..."
28. "content..."
(Lines 26 - 28: Skimming S4 - S9 in section B.1)
29. I guess, just to answer that simply,
30. Well, let me check.
31. So "Absolute humidity is simply the percentage of air that is..."
(Reading S10 in section B.1)
32. "Then the absolute humidity...
33. "If air at 100% humidity is cooled then it becomes supersaturated
34. and the excess moisture precipitates.
35. The dew point is that temperature at which the air will become saturated.
36. This is the temperature at which the air will be saturated.
37. Notice that the dew point is... "
(Lines 32 - 37: Skimming through S14 - S17 in section B.1, occasionally reading a clause of a sentence aloud.)
38. "It takes a lot of heat to evaporate water.
39. "We have seen that one calorie will raise the temperature of one gram of water by one degree Celsius.
40. Therefore, it takes 100 calories to bring one gram of water from it's freezing point to boiling,
41. but an additional 540 are required to actually evaporate the water.
42. Thus, a pan of water on the stove readily comes to boiling,
43. but it takes a long time to boil dry.
44. If it weren't for this we'd have difficulty boiling an egg or making soup."
(Lines 38 - 44: Reading S1 - S6 in section B.2)
45. Ah, hah...Wait.
46. "Therefore, it takes 100 calories to bring one gram of water from it's freezing point to boiling,
47. but an additional 540 are required to actually evaporate the water.
48. Thus, a pan of water on the stove readily comes to boiling,

(table continues)

Table 4 (continued)

49. but takes a long time to boil dry.
50. If it weren't for this, we'd have difficulty boiling an egg or making soup."
    (Line 46 - 50: Rereads S3- S6)
51. "This is also why we perspire.
52. The heat required to evaporate the water comes off of our skins, cooling us off.
    (Lines 51 - 52: Reading S7, S8 in section B.2 [end of the first paragraph in section B.2])
53. Well, I guess I'll do it in sort of a round-about way.
54. First of all, the heat,
55. the hot water of the shower...
56. you get out of the shower, and the water, which is storing the heat on your body, is...
57. you usually dry it off
58. and the evaporation, um
59. Actually, that's not true
60. cause if it's cold outside,
61. the evaporation is a slower process.
62. "The heat required to evaporate the water comes from our skin."
    (Rereading S8 in section B.2)
63. Well, I guess I'd say evaporation and leave it at that.
    (Note: She ended up with the answer she started with, having read and reread various sections of the text. S17, S18 in section B.2 actually contains the answer.)

[a] DW's statements are in regular type face. Material that is being read from the text is in quotes. Italicized information is commentary.

Table 5

Example of a coded protocol for DW's solution to question 12,6

Cognitive Action	Information	Comment/Interpretation
Reads	question	
Identifies	topic and text section	"Latent heat"
Rereads	question	
Recalls	answer from memory	Global answer. "Because of the evaporation process"
Questions	self	"But what is it that causes that?"
Describes	strategy = go to book	
Reads	text B.2 S29-S32	
Reads	text B.2S15	
States	answer (partially correct answer)	"Because the shower was so warm and you'd get out and the air temperature's not as warm as the shower but..."
Monitors/Evaluates	answer	"I know that there's some thing in the book that I'm missing."
Skims	text from beginning of chapter through section A.2	
Reads	text section B.1S1- S3	
Skims	text section B.1S4-9	
Describes	next action	"I guess, just to answer that simply..."
States	need to monitor	"Well, let me check"
Reads	text section B.IS10	
Skims	text section B.1S11-17	
Reads	text section B.2S1- S6	
Recognizes	relevant information	"Aha...Wait"
Rereads	text B.2S3-S6	
Reads	text B.2S7-S8	

(table continues)

Table 5 continued

States	answer that attempts to paraphrase what she's read	Not terribly different from initial answer.
Rereads	text B.2S8	
Decides/States	answer = original	Reverts to original answer

Table 6

Strategies for correct solutions to the five types of questions[a]

	Question type				
	Type 1 (n=35)	Type 4 (n=28)	Type 3 (n=21)	Type 5 (n=14)	Type 2 (n=28)
Percent correct	89%	71%	62%	57%	39%
Search memory (Type A)	.32	.45	.54	.50	.25
Search text (Type B)	.58	.40	.31	.25	.58
Search memory and text (Type C)	.10	.15	.15	0	.08
Text search, reason beyond (Type D)	0	0	0	.25	0
No added processes	.45	.40	.23	.13	.42
Question analysis	.26	.30	.23	.25	.08
Reasoning/Inference	.13	.05	.54	.63	0
Monitoring[b]	.42	.65	.46	1.13	.75
Process	.13	.25	.08	.50	.33
Product	.29	.40	.38	.63	.42

[a]Percent correct solutions is given in parentheses for each type of question. Probabilities in the body of the table are based on the frequency of occurrence of each event in correct solutions.

[b]Underlined data in this row are the sums of the probability of process and product monitoring. Because both could occur in a protocol, the sums can exceed 1.00.

Table 7

Solution strategies for the seven learners[a]

	Learners						
	Native English			Nonnative English			
	MR	HS	DW	LH	GL	EH	II
Number Correct	16	12	12	8	15	10	10
Percent Correct	(89%)	(67%)	(67%)	(44%)	(83%)	(55%)	(55%)
Search Type							
Memory	9(8)	10(7)	5(4)	10(5)	3(2)	3(3)	7(4)
Text	5(4)	7(5)	7(4)	7(3)	15(13)	10(5)	9(5)
Both	3(3)	- - -	4(2)	1(0)	- - -	4(2)	1(1)
Compute	1(1)	1(0)	1(1)	- - -	- - -	1(0)	1(0)
Additional Processing Activities							
None	7	5	2	7	1	5	6
Question analysis	2	2	9	8	9	6	5
Reasoning/inference	5	6	6	5	6	4	5
Monitoring[b]	9	10	14	7	11	9	10
Process	3	8	9	3	6	8	5
Product	8	3	9	4	6	3	6

[a]Maximum = 18 questions. Entries reflect the number of questions whose solutions included a particular search or processing activity at least once. Numbers in parentheses indicate the number of correctly answered questions having that search type or activity.

[b]These data are the number of solutions containing either process or product monitoring.

Table 8

Summary profiles of the seven oceanography learners

	Knowledge	Length of solution	Monitoring
Successful learners			
MR (89% correct)	Expert	Short (67 actions)	Moderate (27 actions)
GL[a] (83% correct)	High	Long (148 actions)	High (46 actions)
Moderately successful learners			
HS (67% correct)	Expert	Short (92 actions)	Moderate (31 actions)
DW (67% correct)	Low	Long (172 actions)	High (76 actions)
Less successful learners			
II[a] (55% correct)	Medium	Short (90 actions)	Low (17 actions)
EH[a] (55% correct)	Low	Short (83 actions)	Moderate (32 actions)
LH (44% correct)	Low	Short (80 actions)	Low (9 actions)

[a]Nonnative English speakers

Table 9
Sample Passage[a]
The Ideal State

Plato was concerned with achieving systematic unity of a society. He did not believe that the primary role of the state was to ensure a feeling of well-being in each one of its participants. According to his theory, the state is a permanent organization that, as a whole, has definite needs and a definite inner structure, and goals that are higher than that of making individuals happy. **In his reflections on society, Plato was concerned with four** (several) **basic issues. First**, he was convinced that increasing individualization threatened the social order. His model of the ideal state provided for numerous measures that would ensure the citizens' conformity, both in their public behavior and in their thoughts and feelings. He provided for supervision and control of all aspects of individual life. **Second**, Plato's conception of the state addressed the problem of the division of labor and specialization. He argued that no human being was self-sufficient and so the coexistence of human beings must be based on mutual exchanges of services. The individual and the state would each attain wholeness and prosper only if labor was divided so that each man did the task for which nature had designed him. **Third**, Plato attached great importance to the optimal size of a city. He thought that the city could be either too small or too large, and he actually fixed the optimum population of the Greek city at 5,040. He strongly believed that excessive territorial expansion and increased population of the state posed a particular threat to its unity. **Fourth**, he attached great significance to the problem of differentiation of wealth within the society. He saw increasing social inequalities as a major source of decomposition of the state because it led to the interests of small groups being put before the interests of the society. He argued for the abolition of private property and the family, regarding both as prime sources of the problem. Plato viewed society as an interdependent system made up of many parts possessing their own interests. He was interested in social facts insofar as they had definite consequences for the integration or disintegration of society. Above all, he was concerned with discovering conditions that were conducive to social integration and equilibrium.

[a]The text for the "Full" signalling condition used the bold faced information. The number condition used only the bold faced sentence, not the specific sequence terms, e.g., First, Second, etc. The Vague condition also did not use the number terms; the topic sentence used the parenthesized term instead of the specific number term. In the None condition, the topic sentence excluded both the specific and the vague quantifier and did not use the sequence markers at the front of each sentence.

Table 10

Mean recall of the target points (max = 4) by Native English speakers (Experiment 2), ESL Speakers (Experiment 3), and Native English Speakers (Experiment 4)

	Signalling condition			
	Full	Number	Vague	None
Experiment 2				
Native English speakers (n = 32)	2.5	1.73	1.67	1.55
Experiment 3				
ESL speakers (n = 16)	2.72	2.44	1.84	1.72
Experiment 4				
Native English speakers (n = 16)	3.13	2.57	2.29	2.38

Table 11

Mean recall of the signalled and unsignalled target sentences in Study 5[a]

		Target Point			
		P1	P2	P3	P4
No points marked	Mono	1.03	.84	1.0	.81
(Number-Only Condition)	ESL2	1.19	1.13	1.0	1.06
	ESL3	.56	.63	.56	.69
Signalled	Mono	1.06	1.13	.92	.91
	ESL2	.91	1.06	.81	1.19
	ESL3	.56	.56	.53	.69
Unsignalled	Mono	1.0	.92	.91	.73
	ESL2	1.13	.57	1.0	.78
	ESL3	.56	.81	.56	.50

[a] The maximum score in each of the cells is 2.

Table 12

Characteristics of the Students in Connector Experiment 1[a]

Characteristic		Native English Speakers	ESL Speakers
Age	Mean	18.75	20.3
	Range	18-20	18-30
Age at which schooling	Mean	- -	11.63
in English began	Range	- -	4 - 26
Scholastic Aptitude Test (V)[b]	Mean	526.8	338.3
	Range	450 - 600	210 - 450
Social Science Courses	Mean	2.78	3.1
in High School or College	Range	0 - 12	0 - 15
Major Field of Study			
Social Science		31%	30%
Natural Science, including Engineering		18%	60%
Undecided		50%	5%
Native Language			
English		100%	0%
Spanish			5%
European (except Spanish)			25%
Asian			70%

[a] All data are self-reported. We did not have access to official student records.

Table continues

Table 12 continued

[b] All 16 Native English speakers reported Verbal SAT scores; only 12 ESL speakers reported Verbal SAT scores. The mean SAT score for freshmen at this university has fluctuated around 500 for the past several years. An additional 7 ESL students reported scores on the Test of English as a Foreign Language (TOEFL) and 2 students reported both SAT and TOEFL scores. The mean TOEFL was 564.7, with scores ranging from 510 to 630. The mean TOEFL score is representative of that reflected in the nonnative English speaking undergraduate population at this university.

Table 13

Mean Number Correct on Each Type of Connector in Connector Experiment 1[a]

	Language Group		
	Native English	ESL	Overall Connector
Connector	(n= 16)	(n = 20)	Means (n = 36)
Additive	6.44	5.7	6.03
Causal	6.56	5.0	5.69
Adversative	6.19	4.35	5.17
Sequential	6.19	4.45	5.22
Overall Group Means	6.34	4.88	

[a]The overall means have been weighted to reflect the unequal sample sizes. The maximum number correct was 8.

Table 14

Distractor Selections in Connector Experiment 1[a]

	Language Group	
	Native English	ESL
	(n= 16)	(n = 20)
Mean errors[b]	6.62	12.20
Distractor Selected		
Additive	.29	.39
Causal	.41	.31
Adversative	.05	.14
Sequential	.16	.13

[a]The Anova was done on arcsine transforms of the proportion of incorrect responses for which each type of connector was selected. The means of the transformed measures were as follows. For the native English speakers: additive = 1.1; causal = 1.38; adversative = .44; sequential = .76. For the ESL speakers: additive = 1.37; adversative = .73; causal = 1.16; sequential = .7.

[b]The maximum number of errors was 32 (8 for each of 4 connectors).

Table 15

The Proportion of Errors on Each Connector Type Accounted for by Each of the Distractor Options for Connector Experiment 1.[a]

	Distractor Options			
Correct Connector	Additive	Causal	Adversative	Sequential
Native English Speakers				
Additive	- - -	.76	.08	.16
Causal	.43	- - -	.09	.47
Adversative	.40	.43	- - -	.17
Sequential	.38	.41	.21	- - -
ESL Speakers				
Additive	- - -	.60	.24	.15
Causal	.47	- - -	.15	.38
Adversative	.49	.40	- - -	.11
Sequential	.50	.29	.21	- - -

[a]The proportions are based on the total number of errors for each connector type. For the Native English speakers the number of errors were the following: On additive slots, 25; on causal, 23; on adversative, 30; on the sequential slots, 29. For the ESL speakers the number of errors were as follows: additive , 46; causal , 60; adversative , 72; and sequential , 70.

Table 16

Student Selection Rate Distributions for Connector Experiment 1

Connector	Percentage of Selections[a]		Percentage of Selections Scored as Correct	
	Native English	ESL	Native English	ESL
Additives	27	33	76	54
Causals	29	28	70	56
Adversative	21	19	91	71
Sequential	23	20	83	70

[a]Total number of selections for the Native English students was 512 and the total for the ESL students was 640.

Table 17

Distribution of Justifications for Correct Responses for Connector Experiment 1[a]

Connector and Justification Category[a]	Native English	ESL
Additives - Total number of correct responses	46	55
Information gives example of concept	.54	.40
Information elaborates prior information	.24	.42
Inappropriate justification	.17	.15
Causals - Total number of correct responses	51	46
Cause-effect relationship between two sentences	.71	.67
Consistent but vaguely stated logical relationship	.08	.04
Conclusion about a cause - effect relationship that was developed over several sentences.	.06	0
Inappropriate justification	.17	.22
Adversatives - Total number of correct responses	45	46
Comparison or contrast with information in the prior sentence; unexpected information	.84	.91
Restriction of the scope of the prior sentence	.09	.04
Inappropriate justification	.04	.02
Sequentials - Total number of correct responses	44	44
Introduces new or next point	.77	.75
Temporal relation	0	0
Sums up prior or previews subsequent information	.20	.23
Inappropriate justification	0	0
Miscellaneous (exclusion, guessing, restating text)	.03	.03

[a]See Appendix A in Goldman and Murray (1989) for a full description of the justification categories.

Table 18

Distribution of Justifications for Incorrect Responses in Connector Experiment 1

Type of Incorrect Response Being Justified	Frequency	Justification Appropriate to: Additive	Causal	Adversative	Sequential	Misc.
Additive						
Native English	14	.14	.57	.07	.21	0
ESL	23	0	.65	.13	.09	.13
Causal						
Native English	9	.44	.22	.11	0	.22
ESL	32	.44	.22	.09	.16	.09
Adversative						
Native English	16	.13	.56	.06	.25	0
ESL	32	.34	.34	0	.13	.19
Sequential						
Native English	17	.24	.35	0	.24	.18
ESL	35	.34	.23	.11	.09	.23

Table 19

Mean Number Correct on Each Type of Connector and Mean Confidence Ratings for Correct Responses in Connector Experiment 2[a]

Connector	Mean Correct	Mean Confidence Rating for Correct
Additive	5.88	5.54
Causal	6.66	5.67
Adversative	5.63	5.98
Sequential	5.22	5.97

[a]The means are based on 32 subjects and the maximum score was 8 for correct responses. Confidence ratings are on a 7-point scale with 1 = very low confidence and 7 = very high confidence.

Table 20

Distractor Selections and Mean Confidence Ratings in Connector Experiment 2

Distractor	Proportion of Incorrect Responses[a]	Mean Confidence Rating for Incorrect[b]
Additive	.27	5.04
Causal	.42	5.39
Adversative	.13	5.07
Sequential	.16	4.97

[a]The mean errors per subject was 8.62 out of a maximum of 32. The Anova was conducted on the arcsine transformations of the proportion of incorrect responses. The means of the transformed proportions were as follows: additive = 1.06; causal =1.44; adversative = .68; sequential = .77.

[b]The means for the confidence ratings were based on a 7-point scale with 1 = very low confidence and 7 = very high confidence. The means are based on 21 subjects because 11 did not have data in all 4 cells.

Table 21

The Proportion of Errors on Each Connector Type Accounted for by Each of the Distractor Options in Connector Experiment 2[a]

	Distractor Options			
Correct Connector	Additive	Causal	Adversative	Sequential
Additive	- - -	.60	.13	.26
Causal	.27	- - -	.27	.44
Adversative	.46	.42	- - -	.11
Sequential	.37	.42	.20	- - -

[a]The proportions are based on the total number of errors for each connector type. The number of errors were the following: On additive slots, 68; on causal, 43; on adversative, 76; and on the sequential, 89.

Table 22

Student Selection Rate Distributions for Connector Experiment 2

Connector	Percentage of Selections[a]	Percentage of Selections Scored as Correct	Mean Confidence for Correct Responses
Additives	26	70	5.54
Causals	32	66	5.64
Adversative	21	82	5.96
Sequential	21	79	5.97

[a]Total number of selections was 1024.

Table 23

Characteristics of the ESL Community College Students in Connector Experiment 3[a]

Characteristic	Mean	Range
Age	27.8	19 - 65
Age at which school ing in English began	20.6	3 - 60
Stanford Diagnostic Reading Test, Grade Equivalent	5.30	2.7 - 10.6
Social Science Courses in High School or College[b]	2.34	0 - 28
Native Language		
Spanish	48.5%	
European (except Spanish)	8.5%	
Asian	43.0%	

[a]Data are self-reported except for the Stanford Diagnostic Reading Test (SDRT) Brown, Form A. The SDRT is administered by the community college for placement purposes when students enroll. Scores were available on all students. Only 2 students reported a TOEFL score

[b]Only 15 of the 35 students had taken courses related to Social Sciences in High School and only 9 had taken such courses in community college.

Table 24

Mean probability of a correct response, mean number correct, and mean confidence rating for correct items in Connector Experiment 3[a]

Connector	Mean Probability	Mean Number Correct	Mean Confidence Ratings for Correct[b]
Additive	.61	4.87	5.11
Causal	.53	4.72	4.92
Adversative	.46	3.76	4.99
Sequential	.39	2.89	5.21

[a]The maximum number correct was 8 per connector type, except for the sequential connector. The maximum correct for the sequential connector was 7.46 because for 19 of the students one of the sequential slots was discounted due to a typographical error in the passage. The error was corrected for the other 16 students. The data for probability and mean number correct are weighted appropriately. Due to this experimenter-error, the ANOVA was done on the probability correct scores.

[b]The means are based on the 32 students who had at least one correct response for each of the connectors. Confidence ratings are based on a 7-point scale with 1 = very low confidence and 7 = very high confidence.

Table 25

Distractor Selections and Mean Confidence Ratings in Connector Experiment 3

Distractor	Proportion of Incorrect Responses[a]	Mean Confidence Rating for Incorrect[b]
Additive	.25	4.76
Causal	.39	4.63
Adversative	.20	4.82
Sequential	.13	4.50

[a]The mean errors per subject was 15.77 out of a maximum of 32 The Anova was conducted on the arcsine transformations of the proportion of incorrect responses. The means of the transformed proportions were as follows: additive = 1.05; causal = 1.36; adversative = .91; sequential = .72.

[b]Three subjects did not have data in all 4 cells and the means are based on 32 subjects. Confidence ratings were based on a 7-point scale with 1 = very low confidence and 7 = very high confidence.

Table 26

The Proportion of Errors on Each Connector Type Accounted for by Each of the Distractor Options for Connector Experiment 3[a]

	Distractor Options			
Correct Connector	Additive	Causal	Adversative	Sequential
Additive	- - -	.50	.39	.10
Causal	.45	- - -	.37	.17
Adversative	.28	.44	- - -	.26
Sequential	.27	.53	.19	- - -

[a]The proportions are based on the total number of errors for each connector type. The number of errors were the following: On additive slots, 108; on causal, 132; on adversative, 152; and on the sequentials, 170. The number of possible errors was 280 for all but the sequential slots, which had a maximum of 261.

Table 27

Student Selection Rate Distributions for Connector Experiment 3

Connector	Percentage of Selections[a]	Percentage of Selections Scored as Correct	Mean Confidence for Correct Responses
Additives	29	53	5.27
Causals	34	42	5.02
Adversative	23	51	5.09
Sequential	16	57	5.14

[a]Total number of selections was 1098, representing 32 blanks for 16 subjects and 31 for 19 subjects, less three instances of no response.

Table 28

Distribution of Justifications for Correct Responses by ESL Community College Students in Connector Experiment 3

Connector and Justification Category	
Additives - Total number of correct responses	61
Information gives example of concept	.44
Information elaborates prior information	.31
Inappropriate justification	.11
Causals - Total number of correct responses	48
Cause - effect relationship between the two sentences	.54
Consistent but vaguely stated logical relationship	.06
Conclusion about a cause - effect relationship that was developed over several sentences.	0
Inappropriate justification	.15
Adversatives - Total number of correct responses	47
Comparison or contrast with information in the prior sentence; unexpected information	.66
Restriction of the scope of the prior sentence	0
Inappropriate justification	.19
Sequentials - Total number of correct responses	34
Introduces new or next point	.26
Temporal relation	.26
Sums up prior or previews subsequent information	.12
Inappropriate justification	.03
Miscellaneous[a] (exclusion, guessing, restating text)	.37

[a]Miscellaneous did not differ by connector type and the .37 represents the rate of this response over all connector types.

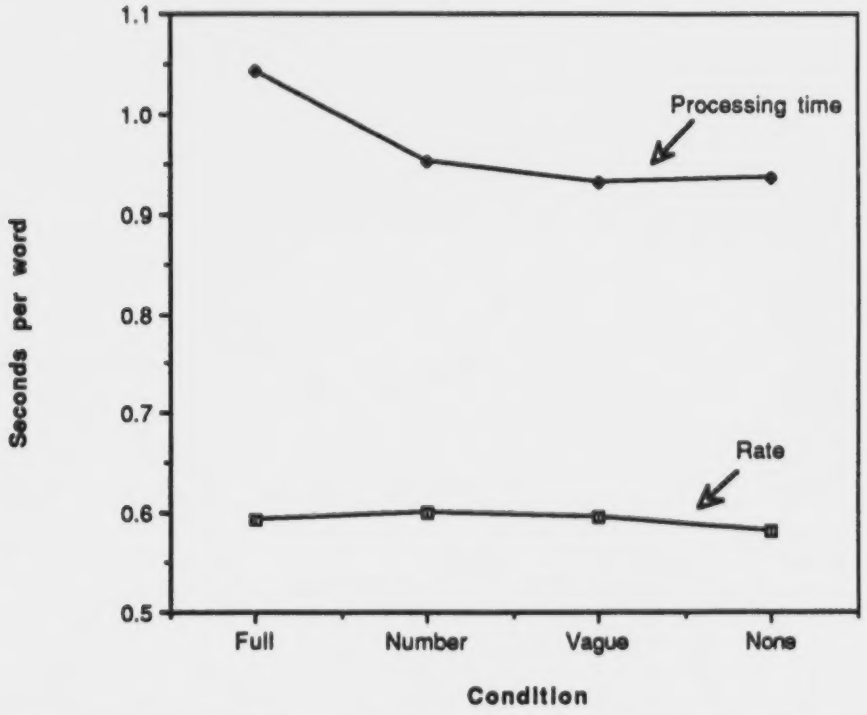


Figure 1: Mean reading rate per word and mean processing time in four signalling conditions for ESL speakers

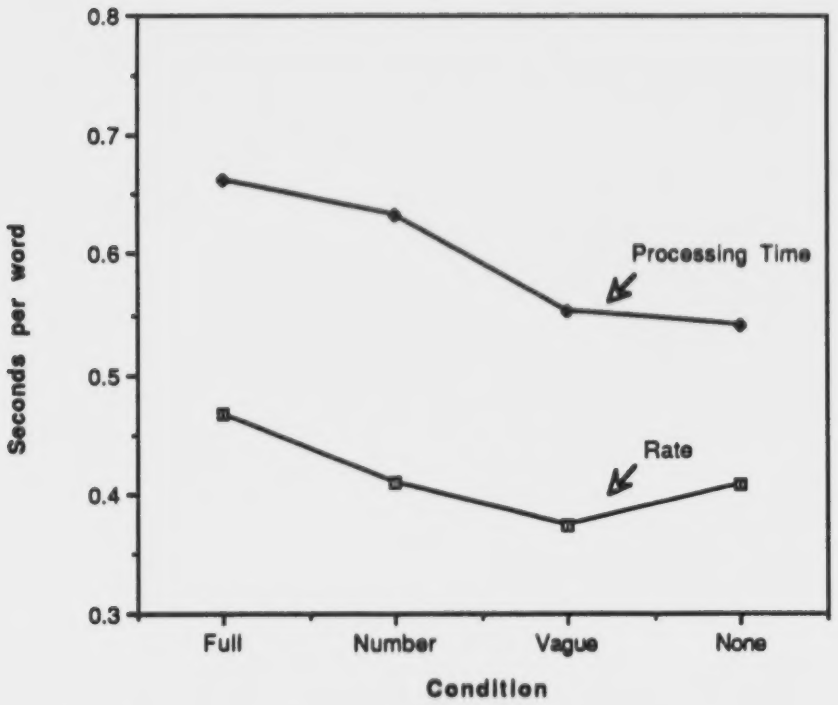


Figure 2: Mean reading rate per word and mean processing time in four signalling conditions for Native English speakers

SEG	MARKER	TIME/READING O
1	I1	8.183
2	I2	5.467
3	I3	7.183
4	TS	5.083
5	P1	5.533
6	P1.1	5.033
7	P1.2	8.450
8	P2	12.517
9	P2.1	4.933
10	P2.2	3.200
11	P3	4.167
12	P3.1	5.083
13	P3.2	5.900
14	P4	12.300
15	P4.1	8.717
16	P4.2	5.467
17	F1	19.533
18	F2	9.717
19	F3	8.400

PASSAGE #13: Pattern Recognition of Speech Signals

Figure 3: Once Through Strategy

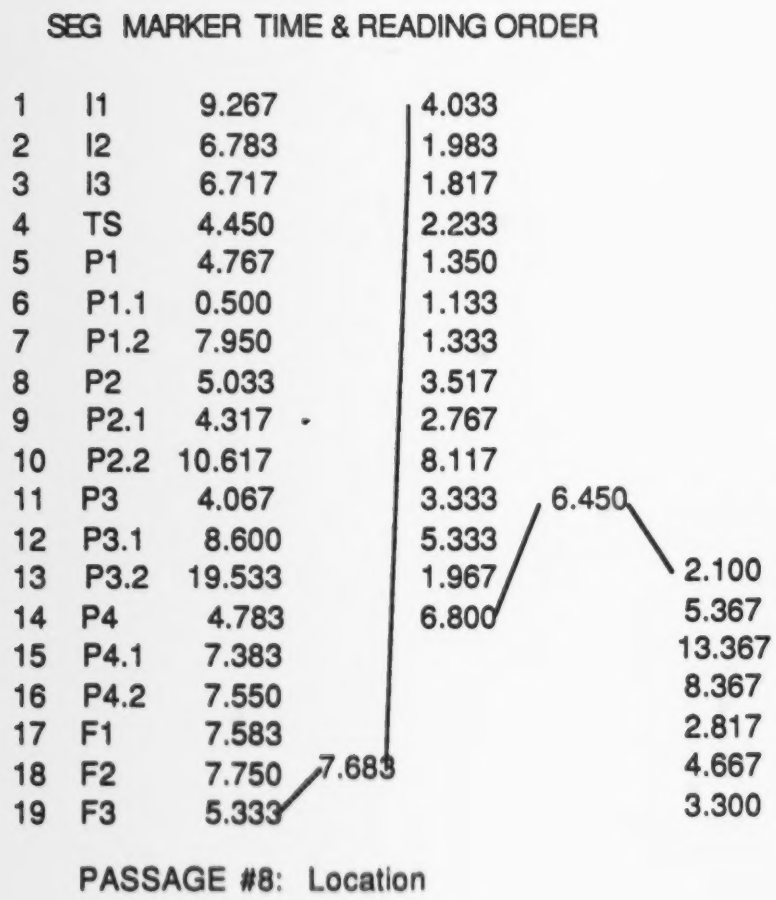


Figure 4. Review Strategy

SEG	MARKER	TIME & READING ORDER				
1	I1	17.400	6.467			
2	I2	2.317	7.833			
3	I3		12.817			
4	TS		4.767			
5	P1		9.500	4.867		4.167
6	P1.1		22.600	2.850		2.967
7	P1.2		3.833	1.983		1.200
8	P2			16.367		3.967
9	P2.1			7.883	1.083	1.617
10	P2.2			7.250	1.250	2.650
11	P3			14.583		2.267
12	P3.1			11.483		0.967
13	P3.2			9.617		1.483
14	P4			7.600		0.883
15	P4.1			4.717		2.050
16	P4.2			5.250		1.167
17	F1			8.733		1.133
18	F2			15.367		2.283
19	F3			20.700		2.533

PASSAGE #16: The Nineteenth Century

Figure 5. Regress Strategy

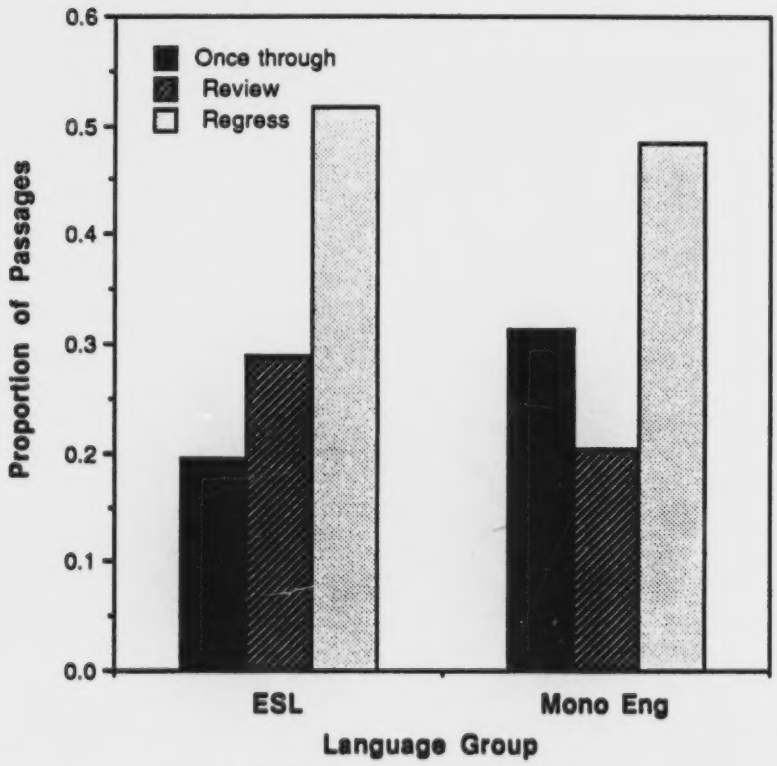


Figure 6: Proportion of Passages Read with Each Type of Approach by Each Language Group

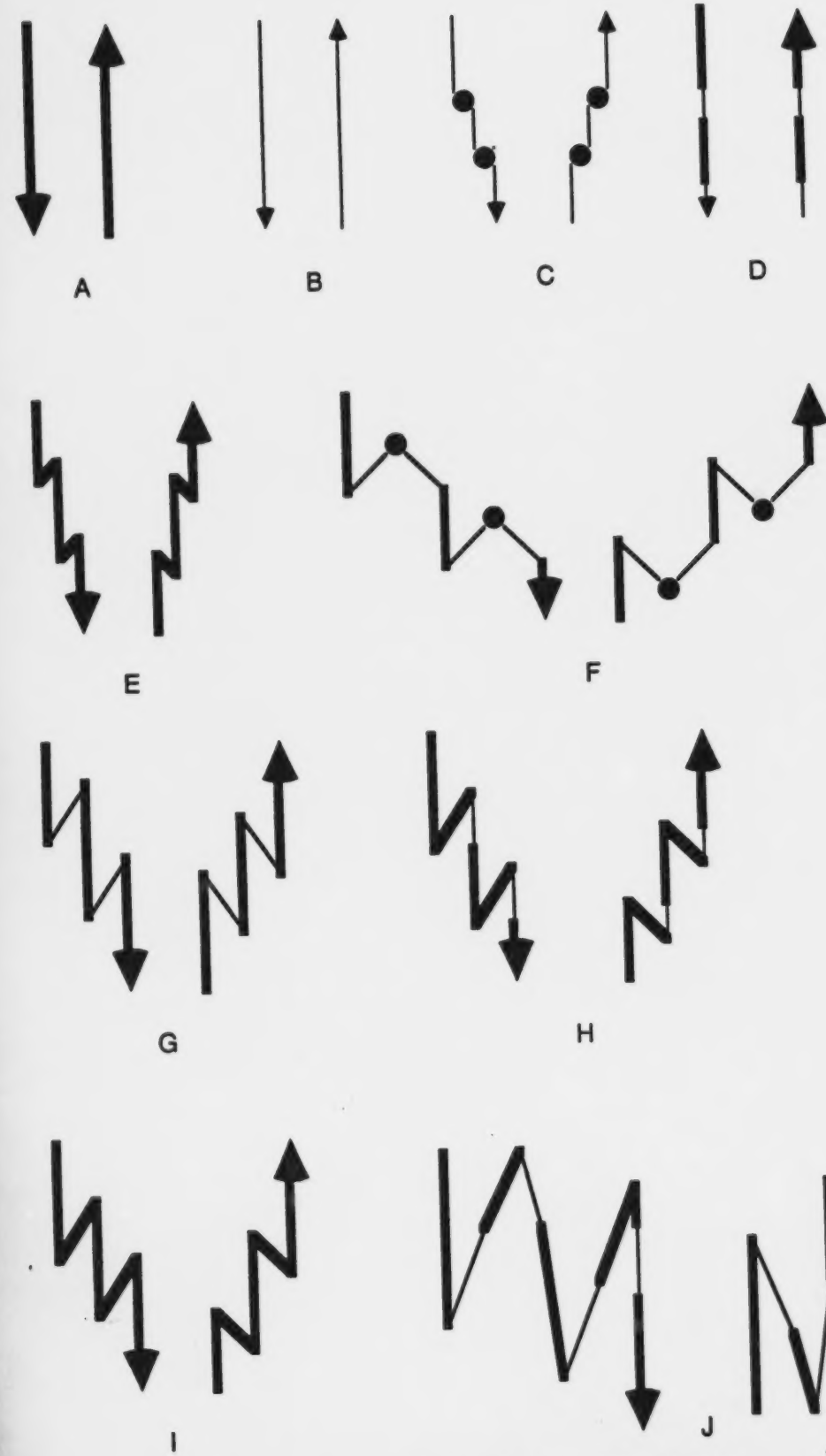
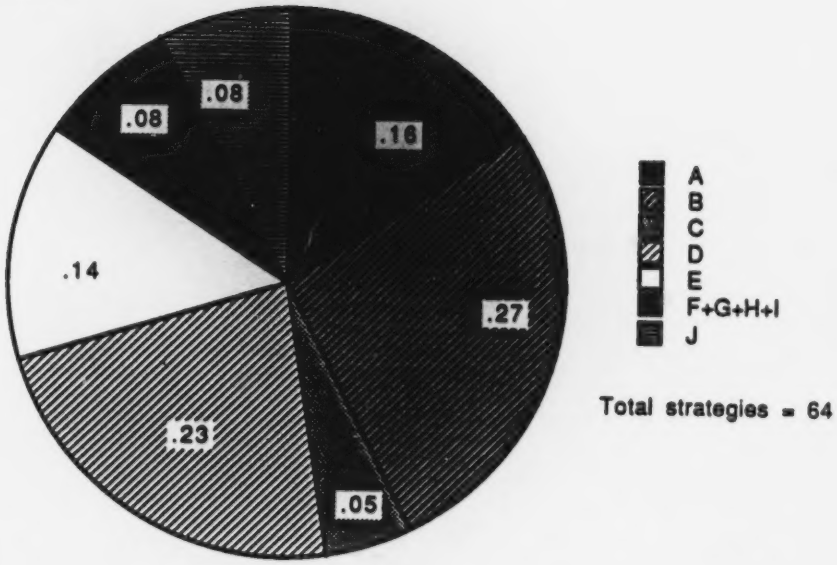


Figure 7: Backtracking Strategies 129

Native English students



ESL students

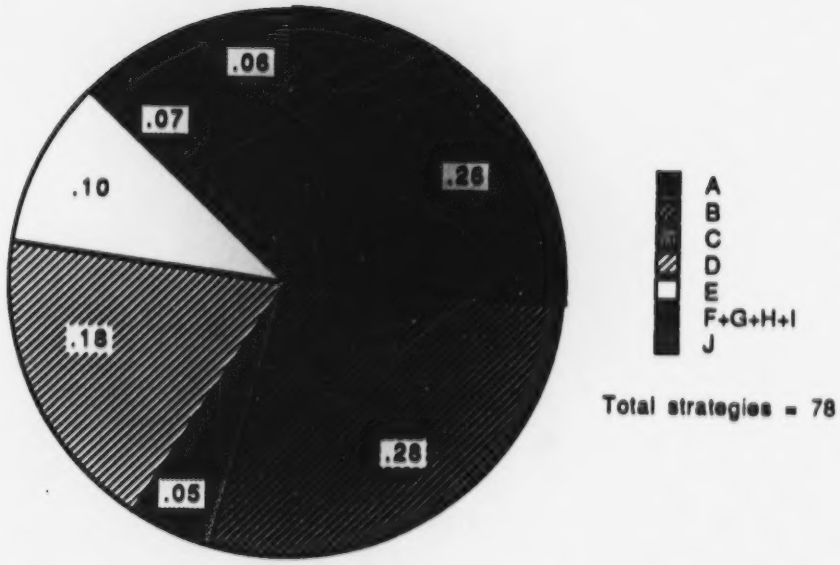
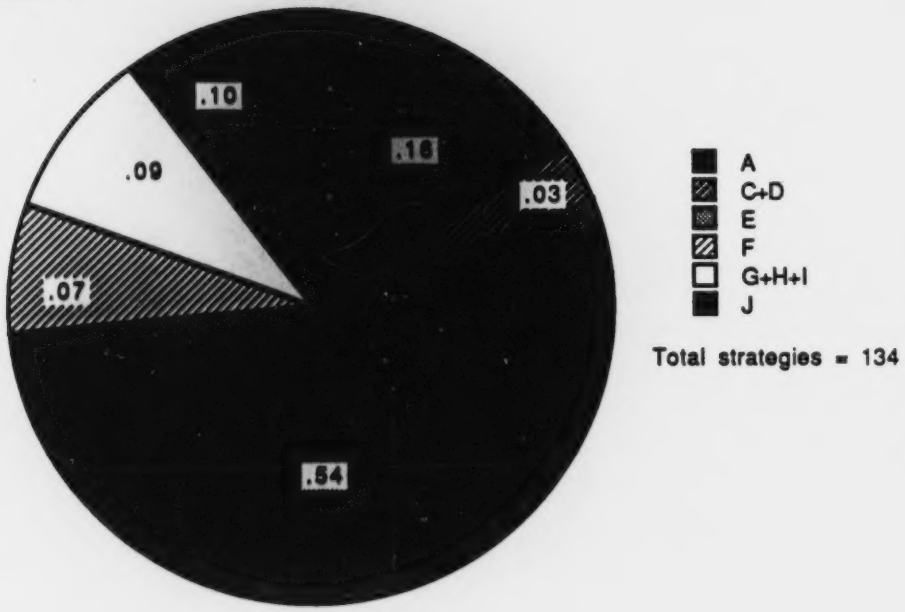


Figure 8: Local strategies for Review Strategy Passages

Native English students



ESL students

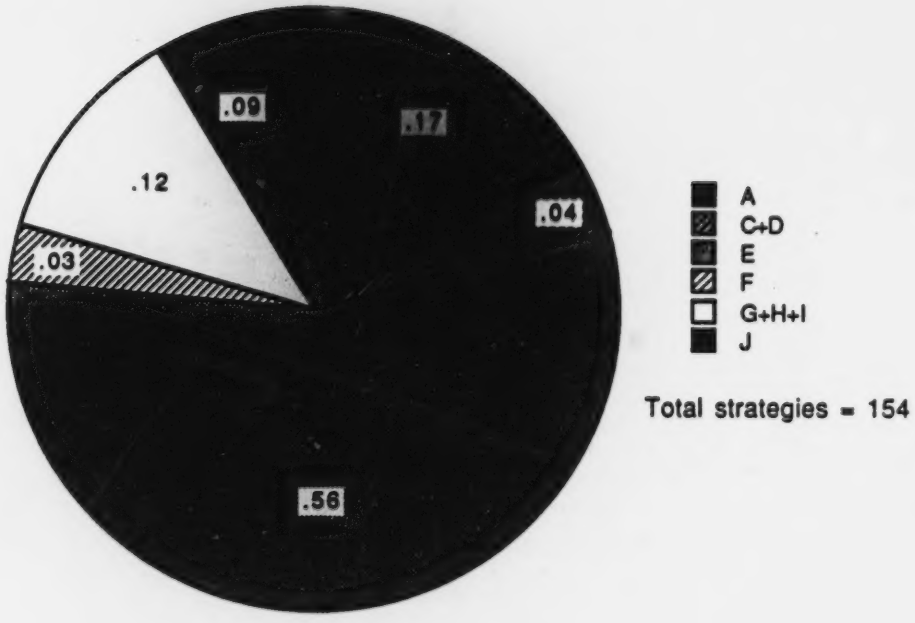
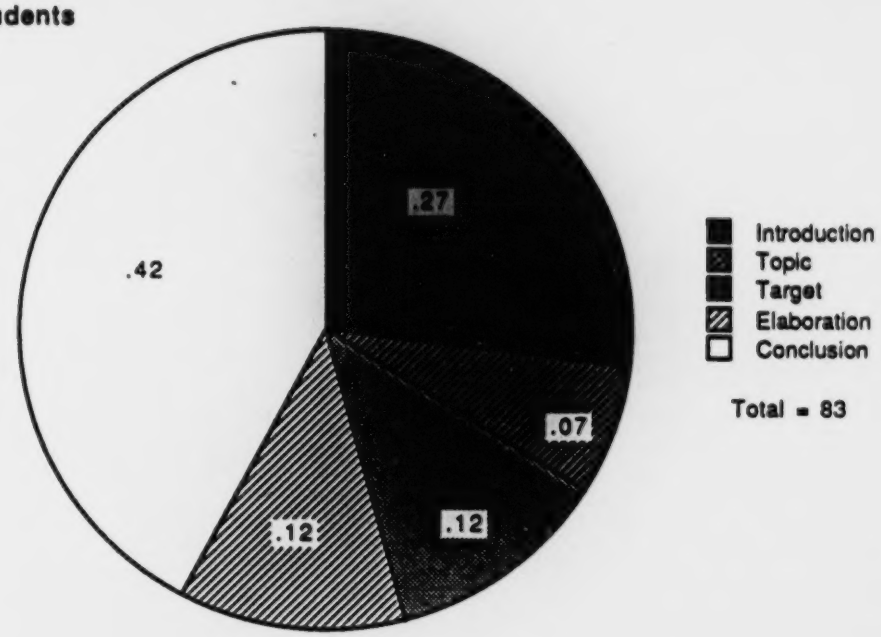


Figure 9: Local strategies for Regress Strategy Passages, Before reaching the end

Native English students



ESL students

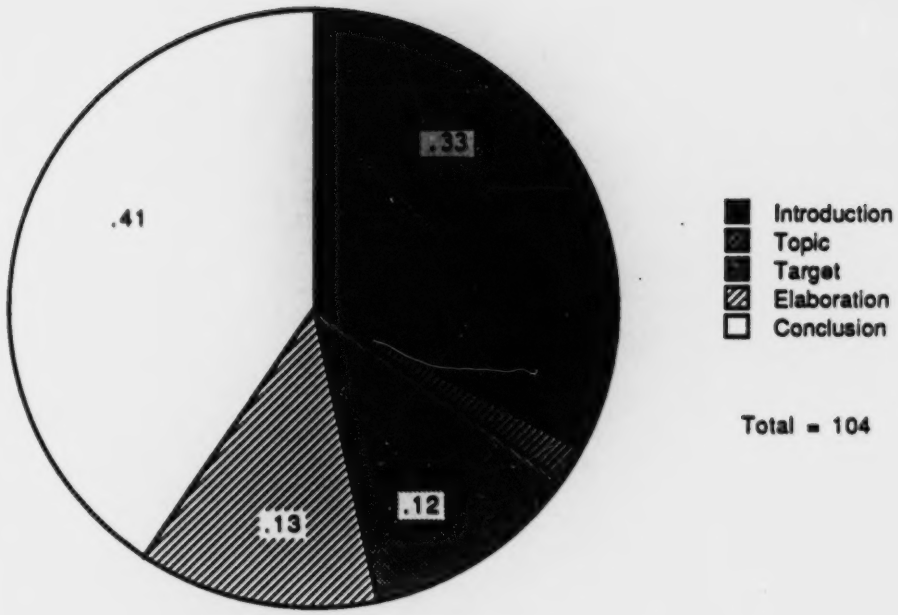
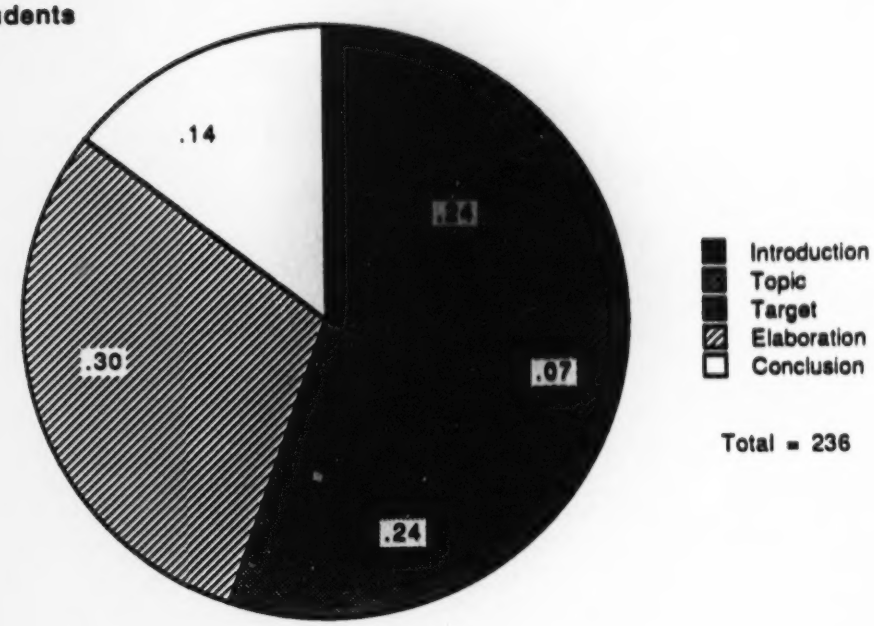


Figure 10: Sentences that initiated direction changes in Review Strategy Passages

Native English students



ESL students

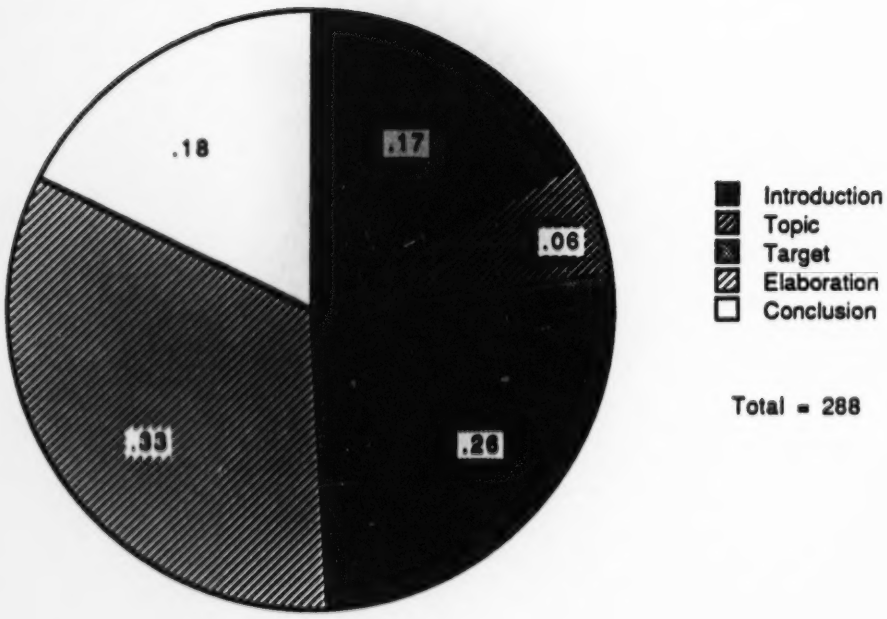


Figure 11: Sentences that initiated direction changes in Regress Strategy passages before reaching the end

ESL Students

Before reaching the end of passage

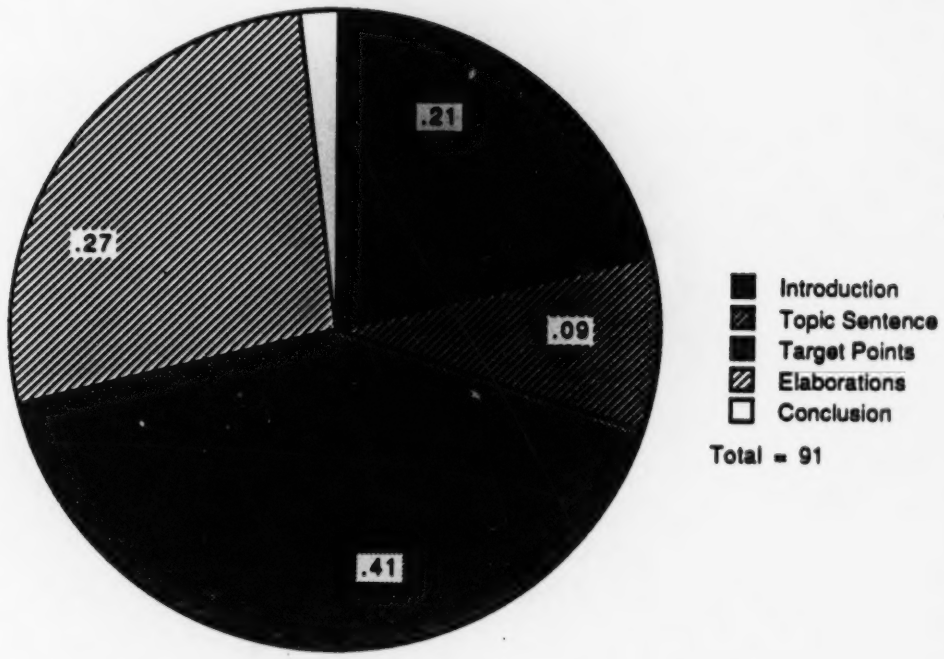


Fig 12. Sentences read to strategically in Regress Strategy passages

For incorrect cloze completions:

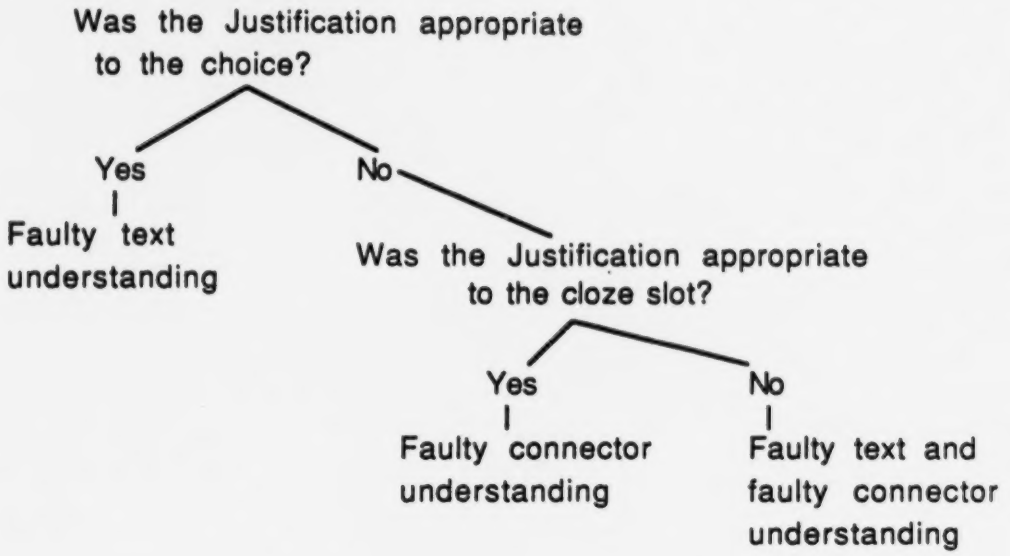


Figure 13: Relationships between incorrect cloze completions and verbal justifications

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